THE ILLUMINATING ENGINEER

LIGHT
LAMPS
FITTINGS
AND
ILLUMINATION

THE JOURNAL OF
GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
LEON GASTER

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GAS
ELECTRICITY
ACETYLENE
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ETC.

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Special Features:

The Lighting of Printing Works—Some Impressions of the Total Eclipse—The Possibilities of Coloured Lighting—Illuminated Hoardings and Electrical Advertising — Smoke Abatement in Schools—News from Abroad—Correspondence, etc.

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The Annual Meeting of the Illuminating Engineering Society

WE take this opportunity of making a few preliminary remarks on the annual general meeting of the Illuminating Engineering Society, prior to the detailed account of the proceedings which will appear in our next number. The report of the Council again served to show how rapidly the illuminating engineering movement is developing. In this country the past session of the Society has been an exceptionally active one. The meetings have been unusually varied, interesting and well attended, and steady additions to the membership have been made, though in this respect more rapid growth is naturally to be desired. The report also showed very clearly that the actual meetings only form a part of the full scheme of work of the Society. Its members have taken a leading part in the very valuable work of the committees operating under the British Engineering Standards Association, and the researches of the Illumination Research Committee, whose reports have been discussed at recent meetings of the Illuminating Engineering Society. There can be no doubt that the existence of this impartial platform has proved very valuable, both in enabling points to be raised that might otherwise have been overlooked and in making this useful work more widely known.

Developments abroad have been equally progressive. In addition to the Illuminating Engineering Society in the United States, there are now societies at work in Germany, Austria, Japan and Holland—the last named a body which only came into existence last year, but under the direction of its energetic secretary, Dr. N. A. Halbertsma, has already shown considerable activity. It is significant that many of the problems discussed abroad are exactly those which have been receiving attention in this country. Hence the function of the Illuminating Engineering Society in London of acting as a clearing-house for information from all quarters seems destined to prove a very important one. Its utility in this direction is obviously enhanced by the existence of its official organ, *The Illuminating Engineer*, which we venture to think is unique amongst publications dealing with lighting in the facilities it possesses for obtaining information of developments abroad.

The Illuminating Engineering Societies in other countries, like our own, have their problems. They, too, have had to consider their position in view of the growing tendency towards the practical application of illuminating engineering by those commercially interested therein. To all firms in the lighting industry the movement is of very great value, and it is natural that they should desire to take advantage of the work that has been done, and of the "goodwill," in the sense of the friendly atmosphere towards recommendations in favour of better lighting, that has been created. But in return they should give the Illuminating Engineering Society every support in their power, frankly recognizing that it can do work and achieve results impossible to any commercial organization.

We were very glad to observe how, at the annual general meeting, this principle was emphatically recognized. The position attained by the Illuminating Engineering Society is due primarily to its impartial position. It is in the interests of everyone that it should be encouraged to continue on the same broad lines of policy, independent of any commercial influence and representing all aspects of illumination on an impartial basis.

We should also like to take this opportunity of expressing the general admiration of the manner in which the new President, Mr. D. R. Wilson, presided at this gathering. Mr. Wilson made a courteous reference to the efforts of the writer and Mr. Dow on behalf of the Society since its commencement in 1909, about 18 years ago. It is our hope that these services will continue to be rendered for years to come. But at the same time it is obvious that the growing work of the Society demands additional assistance. It was pointed out at the meeting that the Society has been quite exceptionally fortunate in being spared any customary expenses, and in profiting by the arrangement under which its proceedings are published in *The Illuminating Engineer*. Its financial resources have hitherto been very moderate—its income is only about one-twelfth of that received by the Illuminating Engineering Society in the United States.

In order that its work may be more rapidly developed, the Illuminating Engineering Society, whilst still maintaining its scientific and impartial position, must therefore secure additional support, either in the form of contributions from those who benefit from the movement or by a substantial increase in membership. No doubt the "new blood" introduced on the Council at the annual meeting will be helpful in assisting the Society to deal with this problem, and enabling it to march on to yet greater prosperity in the future.

In conclusion, we should like to make a special reference to the hospitality of Holophane Ltd., in whose lecture theatre the meeting was held, and to the very interesting series of demonstrations of novel effects and applications of coloured light which they provided for the entertainment and instruction of those present. These demonstrations will be described in the account of the proceedings to appear in our next number.

Light and Advertising

THE holding of the International Advertising Convention last month lends point to the paper by Mr. H. C. Hawkins, which is presented on pp. 232-233 in this issue. The paper was originally intended for presentation at the Advertising Convention in Blackpool last year—an event which had to be abandoned owing to the general strike. The considerations urged by Mr. Hawkins apply equally well now. The vast improvement in the design of posters has been one of the most striking developments of modern advertising. Even during the past ten years progress has been rapid, but only those who can recall the crude efforts of, say, 20 years ago can fully measure the recent advance.

It is, as the author points out, surely an anomaly that most of these posters at present only tell their story during daylight hours. The whole publicity value is lost during the evening hours—which is just the period when most people are free to examine them, and when the public mind is most receptive. During recent years the practice of illuminating posters at night has become more general; yet the number so treated is small in comparison with the number unlighted. According to the calculations of Mr. Hawkins, the cost of lighting, in an important district, is only 30 per cent. of the cost of displaying the poster; in a less important area, where less light is required, 15 per cent. of the cost of display might suffice.

This is surely not an exorbitant amount, considering that the publicity value of a poster is probably at least doubled by the use of artificial light. It has been pointed out that the minds of people are most receptive in the evening, when they are free from their daily work. But this is only one factor in favour of the use of artificial light. It may safely be said that a well-illuminated poster is in itself a very much more more effective object by night than by day; it stands out much more completely from its surroundings and must inevitably attract more attention. We can recall several good examples of floodlighted posters which have attracted crowds during the evening; whereas during the day they were apparently almost unnoticed.

There is considerable scope for skill in the design of such lighting. The provision of sufficiently strong and even illumination often requires care. Much might often be done by adapting the colour of the artificial light to the nature of the design; automatic colour-changing devices might in some cases add greatly to the drawing power, as has been found to be the case for show windows. Impartial students recognize that some degree of compromise is often necessary between the claims of publicity and the requirements of traffic. Illuminated advertisements so attractive as to cause crowds to assemble might sometimes prove awkward to those concerned with the guidance of traffic in streets. Objection has also been taken to some form of illuminated signs on the ground that the brilliancy and alternations of flashing lights are distracting to drivers of motor vehicles. From this standpoint the poster illuminated by concealed lamps seems preferable to some illuminated signs, which have been described as "designed to startle rather than to attract."

No doubt in course of time the provision of artificial lighting will come to be regarded as an integral feature of poster display, for which allowance will be made in the advertising rates. Poster lighting offers an attractive field for the efforts of the illuminating engineer, and a profitable source of revenue to electric supply undertakings, who should do what is possible to encourage development by granting special rates.

The Great Eclipse

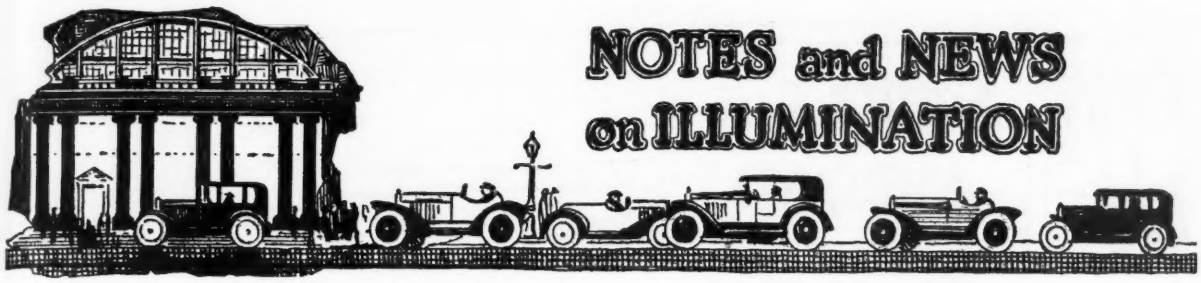
THE extraordinary public interest displayed in the total eclipse on June 28th has been the subject of some remark. In our opinion, this interest was, in the main, a healthy sign, an indication of the greater appreciation of science by the people of to-day. A few were lucky in seeing the passage of the moon's shadow under favourable conditions; the majority were less fortunate, though one would think that even under the worst conditions a total eclipse must be a striking spectacle. But, in any case, almost all of these people will have added something to their knowledge, and many will have come to understand things about the motions of the planets which they never knew before.

It is understood that detailed photometric observations during the eclipse were made by representatives of the National Physical Laboratory, within the belt of totality. This is probably the first occasion on which precise photometric measurements have been made during a total eclipse, though records of the variations in illumination were made during the partial eclipse of 1912, and are recorded in the proceedings of the Optical Convention held in that year. The official photometric data relating to the total eclipse will be awaited with great interest. Meantime we are including in this issue a record of photometric observations made by Mr. J. S. Dow, who also gives his impressions of the eclipse as seen under fairly favourable conditions well within the belt of totality, but not quite at the centre.

The most impressive feature of these results is the sudden drop in illumination, from about 40 to half a foot-candle, during the few seconds preceding totality. It is this final sudden drop that distinguishes a total eclipse from a partial one, when the fall in illumination is gradual, and may be masked by changing climatic conditions. The extent to which this is possible is shown by the record during the first part of the eclipse, when the effect of the gradual obstruction of the sun by the moon was almost completely counteracted by the gradual lifting of the clouds. Hence the illumination during this period remained almost constant. During the second half of the eclipse, when the sun was almost continuously visible, the illumination increased steadily and progressively, ultimately attaining about 2,000 foot-candles—about 4,000 times as great as the average value recorded during the period of totality. This may be regarded as the normal course of events with a clear sky and a sun unobscured by clouds.

Owing to the constantly altering cloud panorama, one would expect that records obtained by different observers, even at distances of only a few miles, would vary considerably. The illumination measured during the period of total eclipse would also be expected to vary according to the position of the observer within the belt of totality. It is quite possible that accurate measurements made on the exact centre line of the belt of totality may show an even lower minimum illumination than that recorded by Mr. Dow, who was stationed about seven miles distant.

This view seems to be confirmed by some interesting figures by observers in different localities, kindly forwarded by Mr. R. C. Hawkins, which reach us just as we are going to press. As might be expected, the values during the period of totality vary greatly, but at Southport the very low value of 1/50th of a foot-candle seems to have been recorded at one instant during totality. It would be very interesting to hear whether such an extremely low value has been recorded at any other station.



Emergency Lighting in Underground Trains

One of our readers, in describing his experiences in one of the trains on the Underground during the interruption of traffic on July 12th, suggests that something better in the way of emergency lighting is needed. The great thunderstorm on that day, and the resultant flooding of sections of the line, led to many trains being held up in between stations. Our correspondent spent more than three hours in darkness in a waiting train. Simultaneously with the stopping of the train the light from the carriage lamps diminished to a red glow. Soon even this feeble glimmer ceased. An enterprising passenger discovered an oil lamp, which gave a feeble light for a short time; but this, too, became exhausted. The carriage was left in complete darkness, except for the intermittent presence of the bull's-eye lantern of the guard. A wait of three hours under these circumstances was, to say the least of it, tedious. Fortunately the train had stopped only a hundred yards or so from the next station, and the glimpse of distant daylight at the end of the tunnel, which could just be seen from the open doorway, was reassuring. We have often commented on the effective artificial lighting now provided on the tubes, and all Londoners recognize the excellent service they afford. Such interruptions of traffic are infrequent and exceptional. Nevertheless they are liable to occur, and we agree that no train brought to a standstill in a tunnel should ever be left without artificial light, which should preferably be sufficient to enable passengers to occupy their minds by reading their papers. In such circumstances light has a reassuring effect; its absence is liable to increase apprehension.

Artificial Sunlight

According to *The Daily Express*, a warning against the indiscriminate administration of artificial sunlight by unqualified persons was recently given by Mr. Neville Chamberlain, Minister of Health, at the opening of the recent National Conference on Maternity and Infant Welfare.

"I think it is necessary to utter just a word of warning," he said, "and to say that the results of artificial light treatment are not yet so certain, the risks of improper application of the treatment are not so trifling, that we can afford to plunge into the treatment without some knowledge.

"When it is given in the proper department of a hospital we know we are all right. I do not want to say that it should be strictly confined to hospitals, but I have thought it necessary, where I had authority to do so, to insist that where artificial light treatment is employed in an infant welfare centre, there shall be responsible for it a medical officer specially trained and a nurse who has suitable experience of the work."

Lighting Common Stairs

A feature of the lighting of various Scottish cities is the necessity for providing for common stairs, passages and private courts. In Paisley, where the lighting is now mainly electrical, the Town Council has decided to undertake the wiring of such places, and lighting at a uniform charge of £1 per lamp per annum. Lighting and extinguishing of such lamps will be effected from the power station, and it is expected that the scheme will be completed in about two years.

Education and Industry

Some pertinent comments on this subject were made by Sir David Milne Watson in his Presidential address to the Association for Education in Industry and Commerce, at their ninth annual conference on June 29th. He dealt particularly with the problem of securing youths with the best possible training for industry. Most industries require specialized training for their workers, yet this is often of a secondary importance. What is invariably needed is character or a sense of discipline and that general intelligence and aptitude which are encouraged by cultural rather than by technical education. The tendency is more and more to demand skilled operatives to control machines, rather than unskilled labour. Level-headedness, adaptability and general intelligence have become qualities of primary importance. Sir David discussed in some detail the problem of how to foster these qualities, and emphasized the necessity for continued training after the age of 14. Apprenticeship, properly applied, should give just this definite training. Day instruction sandwiched into the boy's industrial life is becoming usual. As an illustration of what can be done in this way, Sir David described the technical training provided by the Gas Light & Coke Company at Watson House, and which is supplemented by general educational classes at the Westminster Technical Institute. Another fruitful suggestion was that boys and girls should be familiarized with possible spheres of future work by school visits to the offices and works of local firms. They would thus gain some idea of the nature of the work they may be asked to do and the benefits arising from suitable education; whereas at present most of them have only the vaguest ideas on such matters.

Women in Electricity

The most recent issue of *The Electrical Age*, the official organ of the Electrical Association for Women, is a brightly written publication. There is an introduction by Lady Moir, a description of Baslow Hall (the "all-electric" country house of Dr. and Messrs. de Ferranti, and an account by Mrs. Walton Lawson of the hydro-electric power station at Augst on the Rhine. Elsewhere we find numerous notes on electrical "gadgets," including Len Challoner's contribution entitled "Nursery Magic." Perhaps one of the most significant signs of the times is Miss Margaret Partridge's page for Girl Guides—"Fancies in Fans." The ladies are soon engaged in a highly technical conversation. "But we have alternating current here," objected Bessie. "Should we not have had a squirrel-cage motor here, too?" Fine conversation for a tea-party!

Searchlights for Fire Escapes

An interesting development, recorded by *Electrical Industries*, is a new fire escape equipped with searchlight and telephone, designed by Superintendent Neal, of the Leicester Fire Brigade. The escape has a ladder 85 feet long. To this, in addition to a pump, working independently of any other machine—in itself a novelty—are attached the telephone and searchlight. The searchlight will enable firemen to see the character and quantity of the contents of any portion of a burning building that is not yet involved. The telephone will be used for communication with the fireman at the top of the escape during a fire. This is done at present by shouting or by sending a messenger up and down the ladder. The first escape of the new pattern will probably be supplied to the Leicester Fire Brigade.

The Japanese Illuminating Engineering Society

Copies of the Journal of the Illuminating Engineering Society in Japan are always received with interest, although, as we have hinted previously, the fact that papers are almost invariably printed in Japanese is a drawback to British readers. The titles, however, are now presented in English. The issue before us contains an illustrated account of the lighting equipment in connection with the Imperial funeral at Shinjuka. In this ceremony light evidently played an important part. One of the most curious features is the mingling of the old and the new, for example, traditional Japanese lanterns lining the routes, but supplemented by floodlighting projectors, spotlights, etc. Another contribution by Mr. M. Oyama and Mr. Y. Hayashida describes the lighting of the Memorial Gallery at Meiji-Zingu. So far as one can judge from the illustrations, this is effected on very modern lines; concentrating units above a diffusing skylight are arranged to direct light on the pictures. Other contributions include: "Eye Troubles in Light," by N. Ishiwara, and papers discussing semi-indirect lighting units (M. Horiaka) and Middlekauff's and Skogland's equations (M. Igari). The constitution of the newly-formed Japanese Committee on Illumination is printed in English, and at the end of the volume there is a comprehensive series of abstracts and references to recent papers and articles on illumination. We notice that several of the technical papers issued by the Illumination Research Committee in this country are abstracted.

Glare and Visibility

Experimenters on this subject will be interested in a recent contribution to the *Transactions* of the Illuminating Engineering Society (U.S.A.) by Mr. M. Luckiesh, who has kindly favoured us with a copy of his paper. Mr. Luckiesh points out that the general looseness of expression in this field is largely due to the vague meanings attached to "glare" and "visibility," and to confusion between *cause* and *effect*. The *cause* of glare is the brightness in the visual field, usually light sources and their surroundings, but the state of adaptation of the observer's eye is a contributory factor. The *effect* is complex, and may consist in a feeling of discomfort, a decrease in visibility, or a combination of both. However, when we think of glare we are primarily conscious of ourselves and our bodily comfort, whereas when we think of visibility we are mainly conscious of the object viewed. This may serve as a guide to definitions and nomenclature. The next question is the appraisal of glare and visibility. The latter might be estimated by observation of lettered cards at a given distance, and the determination represented by the formula: "Right answers *minus* wrong answers divided by number of trials." A similar method might be devised for the estimation of glare, except that in this case the subject would be asked to report as to the discomfort, distraction, irritation, pain or other unpleasant features. The results would be less definite than those obtained in the study of visibility, as one can only accept the personal impressions of the observer. But the essential point is that glare is now associated with the impression of discomfort, irritation, etc., while diminution in visibility, often but not always associated with glare, is regarded as a distinct phenomenon.

Karlsruhe Illumination Society

ANNUAL MEETING.

Readers of this journal are aware that besides the German Illuminating Engineering Society there is another body concerned with the technicalities of lighting which has its headquarters at Karlsruhe. That city is also the site of the Lichtechnische Institut, which is under the direction of Professor Dr. J. Teichmüller (the President), and is doing valuable educational work in the field of illuminating engineering. The annual meeting of the society was held in Karlsruhe during July 1st to 3rd, Dr. Teichmüller presiding. The series of papers read on this occasion was evidently designed to deal largely with physiological and psychological aspects of illumination; the contributions by Dr. Teichmüller, Dr. S. Krauss and Dr. O. Kroh all being more or less identified with these aspects. In addition, a paper was presented by Professor Dr. Hellpach, of Heidelberg, on the relation between civilization and the study of light and colour, and Professor Hans Freese dealt with illumination from the architect's standpoint. We look forward to receiving further particulars of this series of papers.

The Study of Radiation

A paper recently delivered by M. Ch. Fabry before the Société Française des Electriciens contained a review of methods of measuring radiation, most of them thermal in principle. Within its limits the photographic plate is doubtless the most remarkable recording instrument. From the standpoint of the illuminating engineer it has the drawback that its selective action differs radically from that of the eye. But it has two unique advantages, in being able to record the intensity of many different elements simultaneously (as in a spectrograph) and in exercising an integrating effect—giving the summation of fluctuating light during a certain period of exposure. In spectrophotographic work the camera is invaluable; the ingenious methods of automatically recording changes in density due to instantaneous exposures also enable fluctuating radiation to be recorded with considerable precision. Some interesting early investigations were recorded by M. Janet in the discussion. He recalled the work of Jean Louis Mouton, who, in 1879, traced out the radiation of the sun and identified the maximum as being near 0.56μ—a close approximation to the result obtained by later workers.

Obituary

MR. A. E. PODMORE.

We learn with regret of the death of Mr. A. E. Podmore, senior partner of Messrs. A. E. Podmore & Co., which occurred on July 8th. Mr. Podmore was identified with the gas industry for many years, and was responsible for much pioneering work in the design of gas lighting appliances. He was one of the first to devise special lighting units for school use, and was likewise early in the field in applying such advances as the superheating of inverted gas-burners. He took a considerable interest in the work of the Illuminating Engineering Society, and even during recent years, in spite of ill health, he was frequently present at meetings.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Relation Between Illumination and Efficiency in Fine Processes, with Special Reference to the Lighting of Printing Works

By H. C. WESTON (Investigator to the Industrial Fatigue Research Board and the Illumination Research Committee).

(Paper presented at the Joint Meeting of the Illuminating Engineering Society and the Joint Industrial Council for the Printing Trades of the United Kingdom, held at the Stationers' Hall, London, E.C., at 6 p.m., on Tuesday, June 14th, 1927.)

SEVERAL codes of lighting are now in existence giving recommended, and in some cases minimum, intensities of illumination for different classes of work done in factories and offices, and, though a number of attempts have been made, chiefly in the United States, to demonstrate the influence of lighting on industrial output, comparatively few investigations have yet been made in which the results obtained could be definitely attributed to a single factor, such as the amount of illumination provided. The Home Office Committee on Lighting in Factories and Workshops published with its Third Report schedules of fine and very fine work, for which minimum intensities of 3 and 5 foot-candles were recommended. The Committee pointed out, however, that considerable research work would have to be undertaken before the formulation of definite standards of illumination for specific processes could be justified, and certain experiments of the kind required have already been instituted by the Illumination Research Committee of the Department of Scientific and Industrial Research.

The work chosen as suitable for these initial experiments was typesetting by hand, a process which, on account both of the nature of the material to be handled and the fineness of the detail to be observed, suggests the need for specially good lighting.

Before discussing the data obtained from these experiments it may be interesting to consider briefly some recent work of other investigators who have studied the relation between illumination and speed and accuracy of work. Ives has studied the operation of letter sorting in American post offices under different conditions of lighting, his experiments being conducted with groups of workers selected according to eyesight. The production of each group was improved by increasing the illumination, the improvement being most marked in the case of those groups containing persons having relatively poor sight. The normal group attained maximum production when the illumination was raised to 8 foot-candles, and the sub-normal group when the illumination was 14 foot-candles. Ives also found that the number of errors diminished as the degree of illumination was increased, the errors being three times as many with an illumination 3 foot-candles as with 14 foot-candles. As a result of subsequent experiments Ives has attempted to express the relation between illumination intensity and the output rate by means of a general formula, so that, by employing a constant, dependent on the nature of the work, the probable rate of production with a given degree of illumination can be calculated. The general conclusion arrived at as a result of these experiments is that, as the illumination is increased, output increases rapidly at first, then more gradually until an intensity is reached beyond which further increase of output is almost imperceptible, or is entirely absent.

This conclusion is confirmed by the results obtained in the case of typesetting, which show the existence of a similar relation between illumination and both speed and accuracy of work. The work studied by Ives is very similar to part of the work of the compositor—that is the reading of the "copy," and it is therefore interesting to note that his results, interpreted on the assumption of an average group of workers, some of whom will have inferior sight, show that an illumination of at least 10 foot-candles is necessary to ensure maximum production.

Some interesting experiments have been made by Ruffer in the Osram laboratory in Berlin to determine the effect of illumination on visual acuity and speed of perception of fine work. The results show a very considerable loss of efficiency with illumination values of less than 1 foot-candle, while up to 10 foot-candles marked improvement takes place. Above this value improvement is much less noticeable, and Ruffer concludes that the best value of illumination lies between 10 and 20 foot-candles. Further experiments, with much higher degrees of illumination and more difficult tests, showed that visual acuity may continue to increase when the illumination is raised to 300 foot-candles. In industry, however, there are relatively few cases in which maximum physiological acuity of vision is necessary in order to ensure maximum production, because the eye is only used for a part of the working period, and during the process of perception the hands are usually proceeding with some portion of the work which does not require constant visual attention.

In the course of investigations made in this country for the Industrial Fatigue Research Board some attention has been devoted to the effect of lighting on output, and it has been observed that in silk, cotton, and linen weaving the daylight rate of output is appreciably reduced when work is done by artificial light where the intensity is of the order of 5 foot-candles—a value which is probably not exceeded in a considerable proportion of our factories to-day.

The full data relating to the first part of the investigation, which is the principal subject of this paper, have been published in a report issued jointly by the Illumination Research Committee and the Industrial Fatigue

Research Board, and a further report dealing with the second stage of the work will shortly be considered by the Committee.

In the first place, it was decided to determine the effect of varying the degree of illumination by studying the output of the compositors. The suitability of output measurements as means for comparing the value of different intensities of illumination depends upon the nature of the work If, for instance, the character of the work is such that rapid action is possible as soon as the eye has perceived the objects requiring manipulation, and this is true of typesetting, the time during which the eye is in active use will be a considerable proportion of the total time required to complete a unit of output, so that anything which reduces the speed of perception will appreciably reduce the rate of output. On the other hand, the size of the objects worked with and the amount of detail which has to be observed may be such that perception is possible in a very small fraction of the time required for manipulation; thus even doubling the time required for perception may have only a slight effect upon the rate of production.

Illumination, however, may affect not only the quantity of output, but also the quality of the product; a careful record was made, therefore, of the number of typographical mistakes, a separate record being kept of the number of turned letters set, since mistakes of this kind are mainly due to difficulty in seeing the nicks in the stem of the type.

Care was taken throughout the investigation to see that no conditions of work were changed except the degree of illumination, and the experiments were made under normal working conditions with the exception of the fact that only artificial light was used. Five different degrees of illumination were tried, the values ranging from 1.3 to approximately 25 foot-candles. The illumination was measured at seven points on the composing frames, and the values referred to are the averages of these measurements. A sixth test was made in daylight, in order to determine the normal rate of output, the frames at which the compositors worked during this test being illuminated by roof lights. The mean daylight factor at these frames was 7.5 per cent., and the illumination range during the first day of the test was between 43 and 266 foot-candles, while that on the second day was between 21 and 495 foot-candles. The minimum of 21 foot-candles was only maintained for about one hour, the illumination being not less than 50 foot-candles during practically the whole of the remaining time on both days. Each test extended over a period of two days, and two compositors were employed setting seven-point type—similar to that used in directories—from "copy" also printed from this type but having ink-written corrections. Output and errors were recorded every half-hour throughout the day and, in the case of the daylight test, the illumination was also measured at half-hourly intervals.

The direct method of lighting was employed in all the experiments made, the various degrees of illumination being obtained by varying the size of lamps used, and by adjusting the mounting height. Gasfilled lamps were used, and in every case they were arranged so that the angle of cut-off was greater than 30°, so as to comply with the recommendation for the avoidance of glare made by the Home Office Committee on Lighting. As an additional precaution against glare the lamps used were half-frosted. In the first experiment the lamps were mounted in ordinary conical reflectors, but in the subsequent tests Industrial Reflector Fitting No. 1 was used, and the spacing of the units arranged so that considerable uniformity of illumination was secured over the whole area of work. The results obtained are summarized in Table I, the performance of the compositors in daylight being taken as the basis on which the relative efficiency attained in artificial light has been calculated. The number of errors is shown as a percentage of the output, and the number of turned letters as a percentage of the total errors. If these three variables are plotted against illumination, using a logarithmic scale for the latter, the points lie practically on a straight line which rises, and in the case of errors falls, to the daylight level. This is shown in Fig. 1:—

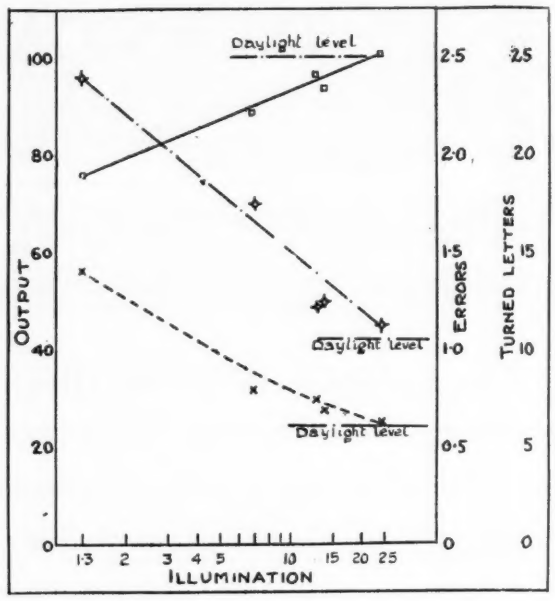


TABLE I.

Test No.	Mean Illum. F.C.	Max. Min Uniformity	Relative Output	Relative Errors	Relative Turned Letters
1 ...	1.3	... 1.60	... 76.0	... 1.41	... 24.0
2 ...	6.8	... 1.30	... 88.4	... 0.79	... 17.5
3 ...	14.0	... 1.37	... 93.7	... 0.69	... 12.5
	Daylight				
4 ...	13.0	... 1.42	... 96.7	... 0.74	... 12.3
	Lamps				
5 ...	24.5	... 1.30	... 100.8	... 0.62	... 11.3
6 ...	Daylight	... —	... 100.0	... 0.61	... 10.5

In the fourth test blue daylight bulbs were substituted for the ordinary gasfilled lamps, and though the mean illumination was 1 foot-candle less than that during the previous test, the output rate increased by 3 per cent., though there was also an increase of errors. The improvement in output, considering that it is, to some extent, offset by increased mistakes, appears to be insufficient to justify the assumption that it is definitely due to the use of artificial daylight lamps. While, however, some slight advantage may be gained by the use of these lamps in composing rooms, it is very doubtful, on the present evidence, whether this would justify the increased wattage, which has to be more than doubled in order to maintain the same degree of illumination provided by ordinary lamps.

Apart from reduction of output, inadequate illumination produces unnecessary fatigue of the worker. This occurs as a result of the longer period during which the eyes must be fixed upon an object in order to see it clearly, or the greater frequency of inspection which is necessary, as well as from the unnecessary movements and additional accommodation and convergence involved if the eyes have frequently to be brought very near to the work. The consciousness of working under adverse conditions is also a cause of mental fatigue, irritation and discontent. The effect of fatigue in the case of compositors, and other persons engaged on work requiring a high degree of accuracy, is most likely to be evident in the quality of the work done, particularly of course, towards the end of the day. The number of mistakes made in the afternoon by the two compositors employed in these experiments was greater than the number of mistakes made in the morning during the first two tests, thus indicating the existence of fatigue, which was practically eliminated, however, when the

illumination was raised to 14 foot-candles. The opinions of the compositors were very definite on the question of fatigue during the first test, and it was difficult to induce them to continue the experiment on the second day with the very low illumination of 1.3 foot-candles. At other values of illumination, however, they did not complain of fatigue, though they did not like working continuously in artificial light.

The data obtained from these experiments afford unmistakable evidence of the necessity for good illumination in printing offices if maximum production and a minimum of errors is to be expected. Obviously an illumination of 2 foot-candles is wholly insufficient for work of this kind, as nearly one-quarter of the possible output would be lost and the number of mistakes increased over 100 per cent. Yet there are probably some composing rooms where a value as low as this is to be found, at least on some part of the case. Even if 7 foot-candles is provided the rate of output may be over 10 per cent. less than could be obtained with better illumination. This is a very serious loss in any trade where labour charges constitute the main part of the cost of production. The best illumination for typesetting appears to be of the order of 20 foot-candles, and it is important to note that if artificial illumination to this degree is provided, by a suitable installation, production is unlikely to be lower than it would be in good daylight. The significance of this fact in the case of underground workshops and of night shifts needs no emphasis. While these remarks apply primarily to typesetting by hand and similar fine work, the lighting of composing machines is hardly less important. The linotype or monotype operator requires good illumination to read his "copy," and it has been shown that for work of this kind not less than 10 foot-candles ought to be provided. But the matrices on the linotype, and the small closely arranged figures on the drum of the monotype machine, have also to be seen easily, and for this purpose 20 foot-candles is not an excessive illumination, though in these cases the additional illumination is probably best secured by means of suitably arranged local lights.

The cost of providing illumination to the extent of 20 foot-candles may, however, appear rather formidable, so that some consideration of the economics of the question will not be out of place. Let us take the simple case of a single compositor. In order to illuminate his frame uniformly with 20 foot-candles, and provide a reasonable amount of general illumination of his immediate surroundings, about 200 watts will be required. The cost of providing this with current at 4d. a unit will be 0.8d. per hour, and the cost of the compositor's time for a similar period at the present time rate will be 1s. 11d., making the cost of labour and lighting 23.8d. per hour. If, however, the illumination is only 2 foot-candles, the current cost will be reduced to 0.08d., so that labour and lighting will now cost 23.08d. per hour, but only 75 per cent. of the production will be obtained. In order to obtain with 2 foot-candles the production given by 20 foot-candles the compositor will have to work another 20 minutes, thus adding one-third to the cost of labour and also one-third to the cost of lighting. The total cost of labour and lighting thus becomes 30.68d., being approximately 7d., or 29 per cent. more than the cost with good illumination.

The economic advantage of the higher illumination is, therefore, very apparent since, not only does the extra light pay for itself, but it also enables a big saving on the cost of labour to be effected. Some interesting figures relating to the cost of good lighting, based on these results, are given in an article by Mr. W. J. Jones recently published in *The Illuminating Engineer*.

So far, only the degree of illumination has been considered, but the best method for providing that illumination has also been the subject of experiment. The same method of investigation—which has already been described—was adopted, and direct general, semi-indirect, local direct, indirect, and a combination of semi-indirect and local lighting was tried, together with a system of indirect lighting with partial daylight correction.

During these tests the degree of illumination was kept constant, only the type of fitting being changed. The standard illumination adopted was approximately 10 foot-candles, this value being chosen so that the output rate would be below the maximum, thus ensuring the possibility of a rise or fall in production in response to the system of lighting used.

A preliminary series of tests was made with the original compositors, but the results were not very conclusive, and some further tests were made with six compositors. The results obtained from the second series are summarized in Table II, the best output being taken as the basis for calculating the relative efficiency obtained with the several systems tried.

The best output was obtained by the direct method of lighting, the fittings used being Industrial Reflector Fitting No. 1, mounted about 10 feet above the floor. There is, however, very little to choose between the results with this method and those obtained with semi-indirect lighting provided by means of Benjamin bowls with top reflectors. The compositors preferred the semi-indirect method because the glitter from new type was less noticeable.

TABLE II.

System	Relative Output	Relative Errors	Relative Turned Letters	Total Wattage Installed
Direct	100.0	0.43	16.7	600
Semi-direct	99.3	0.39	14.4	600
Semi-direct and Local	97.8	0.33	19.6	120 and 600
Indirect (Daylight Correction)	97.3	0.32	22.3	1,000

The third method tried was a combination of semi-indirect general lighting with direct local lights, approximately 50 per cent. of the total illumination being provided by each type of source. The compositors were favourably impressed with this system, and considered it better than semi-indirect lighting alone for seeing the type. There was, however, a drop in output of 1.5 per cent., though the percentage of errors was also reduced. In all the tests a rheostat had to be used to adjust the illumination to the standard value, but the dimming necessary in order to obtain the desired proportion of local light was sufficient to make the light rather red. This fact probably accounts for the compositors' opinion that the light was softer than that provided for the first two experiments, but as the degree of illumination was the same there seems some reason to suggest that a slightly tinted light may be more comfortable than a white light for dealing with type. This suggestion is supported by similar opinions expressed by the compositors during the fourth test, when a tinted light was also used. The fittings provided for this test were of the indirect totally enclosed type, consisting of a white-enamelled opaque bowl, surmounted by a trumpet-shaped pale-blue glass intended to give an approximate daylight correction, without the coldness of north light. In view of the compositors' dislike of the colour of the light provided by the daylight bulbs used for one of the original series of tests, it was not anticipated that these fittings would find much favour with them, but, on the contrary, they were unanimous in declaring this method of lighting to be the best they had tried, so far as restfulness and absence of glare were concerned. They considered, however, that the light was not good enough for seeing old type, though as the standard of illumination was maintained the real difficulty was probably the relative absence of shadows. This view is supported by the increased proportion of turned letters set during the fourth test, but, apart from this, there was no significant difference between the performance of the compositors during this test and that of the preceding one.

Two of the compositors employed for the experiments just described were those engaged in the preliminary experiments with different methods of lighting, and it may be of interest to compare their performances in both series of tests. Table III is given for this purpose.

Here again, it is evident that if general lighting only is provided, it is of little consequence whether the

fittings used are of the direct or semi-indirect type. The cost of lighting will, however, be rather greater with the semi-indirect than the direct method, and there may be greater difficulty in keeping the fittings clean—which must, of course, be done if the efficiency of the installation is to be maintained.

TABLE III.

System	First Series Output	First Series Errors	First Series Turned Letters	Second Series Output	Second Series Errors	Second Series Turned Letters
Direct	100.0	0.58	12.7	98.3	0.62	18.7
Semi-indirect	96.6	0.53	14.8	100.0	0.65	15.8
Semi-direct & Local	—	—	—	96.6	0.50	21.5
Local only	93.7	0.65	15.4	—	—	—
Indirect	92.9	0.51	19.1	95.6	0.46	21.8
Local with Glare	92.5	0.39	19.6	—	—	—

The saving effected by the adoption of good lighting is so considerable, however, as to allow ample margin for the use of the semi-indirect method if, by so doing, glare from the type can be reduced, as appears to be the case.

The combination of semi-indirect and direct local lighting appears at a slight disadvantage, but this is so small as to be hardly more than the difference which might occur in two experimental observations of this kind irrespective of any change of lighting. In actual practice this method of lighting composing rooms may be found the most convenient. Local direct lighting by itself, even if care is taken to avoid any direct glare from the lamps, does not compare favourably with other methods of lighting, while if the lamps are ineffectively screened the inferiority of this method is still more apparent. The reasons for this appear to be the difficulty of securing uniformity of illumination, even over the actual area of work, the difficulty of avoiding unpleasant glare from the type, due to the close proximity of the light sources, and the excessive contrast between the brightly illuminated work-place and the ecclesiastical gloom of the general surroundings. Indirect light also appears to be unsuitable, except in the case when the daylight fitting was used, though even then there is an appreciable loss of production with the two compositors under consideration.

To sum up the results of the experiments with methods of lighting, there appears to be little doubt that a considerable amount of general illumination in composing rooms is necessary if the best results are to be obtained. General lighting alone, whether direct or semi-indirect, will be satisfactory, providing the degree of illumination is sufficient, but in some cases there may be structural obstacles which will make an installation of this kind inadvisable, and a combination of general and local lighting should be employed. If this is done a considerable portion of the total illumination should be provided by the general sources, which should not be installed merely with the idea of relieving some of the surrounding gloom usually associated with local lighting. Even indirect lighting is an economic proposition, in view of the figures which have been given in this paper, though there is no evidence of any particular advantage of such a system, apart from the opinions of the compositors on the question of glare from the type.

The psychological effects of the method of lighting used may often be of more importance than its direct influence on the facility with which work can be done, so that the rate of output probably affords a less sensitive indication of the relative merits of different methods than of different degrees of illumination.

The provision of adequate and suitable lighting in factories and workshops will undoubtedly benefit industry rather than impose an additional burden on it, but though much eye fatigue which exists at present can be eliminated in this way, there are a number of industrial processes involving work of so fine a character that no amount of illumination will enable them to be carried on as comfortably and efficiently as might be. In such cases the illuminating engineer can do no more than install really good lighting, and the ophthalmologist must be relied upon for further help in reducing the eyestrain associated with the work. That this can be done has been demonstrated by experiments recently made for the Industrial Fatigue Research Board, in which operatives from several different industries have been supplied with specially prescribed spectacles, which reduce the amount of accommodation and convergence required for doing fine work.

In the case of linking, a process in the hosiery trade, where eyestrain was thought to be due to lighting difficulties, relief could only be obtained by the use of glasses, and these enabled the output of the operatives fitted with them to be increased by 10 per cent. A much larger increase of output has been obtained in another case, partly on account of the reduction of accommodation and convergence effected, and partly owing to the correction of astigmatism, which, but for these experiments, may have remained unsuspected for a long time. Probably a number of complaints directed against lighting may also be due to individual defects of vision. Though the work of the compositor does not appear to require the use of magnifying glasses by men having normal sight, it is worth while mentioning these experiments as illustrating the loss of production which may result from defective eyesight. There was, or is, a reluctance on the part of compositors to resort to glasses, owing to the impression that if they did so there would be evidence of failing sight and consequent unfitness for their occupation. The fallacy of this idea should be apparent, and the use of glasses, when necessary, ought to be regarded as a natural and valuable means for maintaining, and even increasing, productive capacity.

Discussion

Mr. C. C. PATERSON congratulated Mr. Weston and his collaborators, who had done some exceptionally difficult work extremely well. Any experiments designed to trace the relation between illumination and working efficiency must be hedged about by many safeguards if reliable deductions are to be made. It was particularly desirable to secure the full co-operation of experts in the industry studied. He was glad to say that in the particular instance under consideration the wholehearted co-operation of the printing industry had been extended, and the success achieved was largely due to this fact. Their assistance had been extremely valuable in ensuring the adoption of precautions necessary in order to obtain reliable results.

The curve showing how the output and the absence of mistakes both improved definitely and constantly with the increase of illumination served as an indication of the soundness of the lines followed. The results were not merely of direct interest to the printing industry, but, if properly interpreted, would be found to apply to many other industries. It was evident that investigation on similar lines would present difficulties in the case of many industries. The particular process selected, i.e., composing, owing to the constancy and uniformity of the kind of work done, was specially suited to enable an investigator to correlate cause and effect. In the case of most industrial processes there were so many more variable factors to be considered that the correlation of production with illumination is almost impossible.

The main conclusion from the investigation was the increase in output and in efficiency with increasing illumination. Attention had been drawn to the possible effect of other conditions in lighting, besides the illumination provided. The result showed that from an efficiency and output point of view, and with the various systems used, the type of distribution of light had not much effect, provided that there was absence of glare.

In conclusion, he again congratulated Mr. Weston and those working with him on the results of their labours, which must be a source of real satisfaction to them.

The CHAIRMAN said that as Mr. Paterson had referred to the assistance derived from the industry, he would mention specially two gentlemen whose aid had been exceedingly valuable—Mr. Goodwin and Mr. Holmes,

the Secretaries of the Joint Industrial Council. He hoped that they would join in the discussion, as he was sure that all present would like to hear their views.

Mr. A. E. HOLMES (Secretary of the Joint Industrial Council for the Printing Trades of the United Kingdom) said that he was not qualified to speak on the scientific aspects of this problem with the same authority as some of those who were experts on illuminating engineering, but there could be no doubt as to the great importance of this question to the printing industry. He believed that this would be appreciated even more fully when the complete results of the research were available. It would be interesting to have some data on the effect of lighting conditions on the health of workers. He had himself worked in places where the lighting was very bad; in such circumstances one noticed that some men had to stoop over their work in the effort to see things clearly.

He knew that both on the part of employers and on the part of workers there was the greatest desire to do everything to help the investigation and to ascertain the best methods of illumination. Good lighting would necessarily have an influence on production, and he had not the least doubt that before very long many employers would adopt the system of lighting recommended as a result of this investigation. In order to study this somewhat complex subject thoroughly, prolonged investigations might be necessary, and Mr. Weston and the others concerned had so far had only a limited time in which to experiment. The same applied to the question of the effect of improved lighting on the general health and efficiency of workers. Possibly in about 12 months' time useful data on the improved production and better health resulting from the application of the principles recommended as a result of this investigation might already be available.

Mr. G. HERBERT desired to express his great appreciation of the great amount of trouble taken by the author in preparing this paper, and of the useful data put before the meeting. He (Mr. Herbert) had always had a special interest in the lighting of printing works, which was admittedly a difficult proposition. If when the investigation was concluded, the recommendations could be summarized in a concise and simple pamphlet he felt sure that this would be extremely useful to the printing industry.

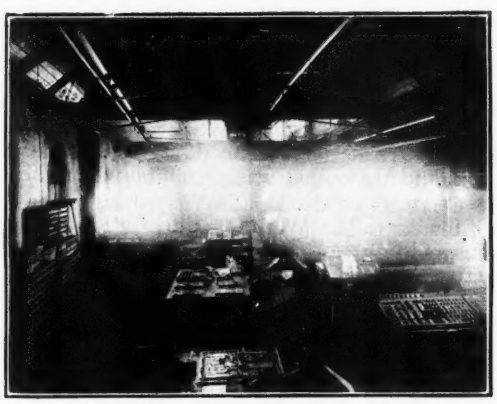


FIG. 1.—Original method of Lighting showing Glare from exposed sources and uneven illumination (3 foot-candles).

The only quarrel he had with Mr. Weston was that he had done his work so thoroughly that he had left no room for criticism, and those joining in the discussion would no doubt endorse the recommendations made in his paper. It was true, as had been remarked, that there were many printing works where better lighting was urgently needed. At the same time, he did not want those present to think that there were no works illuminated on the lines advocated in the paper. Within his own knowledge, during the last ten or twelve years a number of very up-to-date installations had been carried out. Mr. Herbert then threw upon the screen a number of lantern slides of modern installations, commenting on the high illumination and absence of glare as features of the arrangements.

Two of these views, showing the effect in a printing works before and after the improvement in lighting, are reproduced in Figs. 1 and 2. The improvement in regard to elimination of glare is manifest; likewise the better

FIG. 2.—Greatly improved Lighting, lamps shaded, and even illumination (12 foot-candles).

diffusion of light, as illustrated by the uniform illumination and absence of deep shadows shown in Fig. 2. The illumination had been increased from an original value of approximately 3 foot-candles to 12 foot-candles. This was typical of the improvements that had taken place in the last few years.

Mr. C. RAPHAEL enquired whether the numbers in the tables relating to turned letters were presented as percentages.

Mr. WESTON replied that the numbers represented percentages of errors.

Mr. S. B. LANGLANDS said that the report summarizing the work of the Illumination Research Committee had proved of great value in the north of England in connection with efforts to improve the lighting of printing works. There, as in London, it had been found that people had responded very willingly to suggestions for improvements. Personally he, like Mr. Herbert, had always had a warm place in his heart for the printing trade. He remembered the old days of flaming gas lights brought close down to the frames, and the dexterity of the compositor, who seemed to work by a sense of touch, just as a typist does.

He would like to add his tribute to the good work which the investigators had done in studying the effects of better lighting in this exacting industry. There was much in common between the requirements in the textile and printing trades. He thought that, in general, requirements would best be met by a happy combination of local and general lighting. He would suggest that the colour of the light should receive special attention. He believed that eventually special tints might prove to be helpful in diminishing eyestrain and securing maximum visual acuity.

He had much enjoyed the paper, and the work that had been done would be followed up in the north of England with a view to giving the printing trade practical assistance in improving the lighting.

Mr. A. E. GOODWIN (Secretary to the Joint Industrial Council for the Printing Trades of the United Kingdom) also thanked Mr. Weston for the work he had done and for his able paper. He considered that great credit should also be given to the Chairman (Mr. D. R. Wilson) for his special services. Those who had served on the committee had been impressed by his very practical grasp of the subject, and he felt sure that under Mr. Wilson's guidance the committee would continue to do work of great practical benefit.

He would like to make it clear that the work of the illuminating engineers had by no means been brought to an end by these investigations. The Joint Industrial Council cordially welcomed what had been accomplished, but they realized that there were problems still to be solved. They were anxious to encourage any improvements leading to better conditions and the preservation of the health of the workers.

Mr. Goodwin attached special importance to the elimination of glare. He also referred to the difficulty of dealing with new type owing to the " glitter " caused by reflections of light. It had been suggested that such type should be " aged " before being used.

Mr. Weston had very clearly demonstrated the economic value of good lighting, and shown that an expenditure of three farthings per hour secured a saving of 8d. per hour. This was a point that would not only appeal to the master printers, but to employers in other industries. The experiments had necessarily been conducted with a small number of men under special conditions. It was desirable that these results should be confirmed by experiments conducted for longer periods and on a larger scale. Many employers in the printing trade were now consulting with experts as to the best methods of lighting, and he had no doubt that many of them would be quite willing to make the necessary expenditure to improve lighting conditions if they could be sure of the correct methods. Many people were not yet convinced as to the advantages of increased general lighting. There was still a tendency to prefer local lighting, and employers were not always readily convinced as to the desirability, on psychological grounds, of illuminating the surroundings; their idea was rather that a high local illumination encouraged illumination on the work. It was for the illuminating engineer to convince employers of the real value of the methods advocated. He suggested that it would be expedient to bring forward only principles on which there was general agreement, and to avoid recommendations on points still the subject of difference of opinion on the part of experts. When specialists differed their advice was commonly disregarded. On the other hand, where there was agreement suggestions would meet with acceptance, and greatly benefit the printing industry.

Mr. W. M. BOWER (Linotype and Machinery Ltd.) said that he spoke as one associated with the manufacture of printing machinery rather than as a practical printer. He complimented Mr. Weston on his paper. Though he had gone deeply into the matter, his work was not yet done. He (Mr. Bower) thought that the lighting was of great importance in relation to the operation of composing machines. The efficiency of the linotype machine depended on proper lighting, and this was fully realized by the manufacturers. The little bracket and holder seen in the picture of this machine, which had been thrown upon the screen by Mr. Weston, was provided by the manufacturers, and was considered the best method of lighting the copyholder; this device formed an integral part of the equipment. In this case proper lighting did not necessarily mean very strong lighting, but it was very important that the eyes of operators should be protected from the glare of the lamps used. This was effected by a metal screen which also served to concentrate light on the copy and on the matrix. In actual practice a really efficient operator scarcely had to read the letters on the machine, but he had, of course, to read the copy, and therefore required a good light.

Mr. W. J. JONES joined in the expression of thanks to Mr. Weston for bringing such an important piece of work before the meeting. This work had excited the admiration of people in different parts of the world, and was regarded as of great importance because of the impartial nature of the enquiry and the authority behind it. With regard to the figure of 20 ft.-c. which Mr. Weston had mentioned, he was under the impression that the desirable limit to the illumination was almost entirely one of economics, i.e., how much one could afford to pay for better lighting in view of the saving in labour.

Could Mr. Weston explain why, under apparently average daylight conditions, a certain output was obtained with 50 foot-candles, and, under artificial lighting, about the same output with only 20 foot-candles? He had recently seen an installation where there was a desire for a soft and mellow tone, and lamps of a flame tint were used. It was possible that the adoption of suitably tinted lamps might prove of value in diminishing the harshness of white light.

Mr. L. GASTER complimented Mr. Weston on his lucid and able paper. The Society also owed thanks to the Illumination Research Committee for sanctioning the presentation and discussion of this useful data on its platform. He (Mr. Gaster) also wished to associate himself with the expression of thanks to Mr. Goodwin and Mr. Holmes for the very sympathetic and practical way in which they had co-operated in these experiments. The impartial and representative nature of the committee lent special weight to the conclusions arrived at. In any enquiry into the relation between illumination and output great care was necessary. Some of the results might with advantage be confirmed by experiments for a more prolonged period and on a larger scale. Possibly some of the leading firms in the printing industry might consider initiating such experiments in their works, the investigation being conducted on similar lines to that already done, so that the results might be comparable.

Allusion had been made to the expense of furnishing 20 foot-candles of general illumination, and also to the tendency to prefer local lighting. In most cases a combination of local and general lighting might prove the best solution, say, 5 to 8 foot-candles of general lighting, the value being raised to 20 foot-candles or more at the actual point of work by well-shaded local lights. A moderate degree of general lighting was advisable; otherwise the contrast between the brightly lighted working area and the dark surroundings was fatiguing.

There were many other problems involved in the lighting of printing works besides those in the composing room. There was, for instance, the illumination of linotype and monotype machines, to which Mr. Weston and Mr. Bower had referred. The lighting of printing-off rooms, often occupied by bulky rotary presses, also presented difficulties. The mounting of special units to facilitate inspection of machinery, as an integral part of the design of the machine, deserved consideration. This method had been proposed in the textile industries, where similar problems arose. He was much interested in the lamp bracket and holder attached to the linotype machine, to which Mr. Bower had referred, but thought that the lamp and reflector necessary to provide the desirable minimum illumination should be specified.

Mr. H. C. WESTON, in answer to the query of Mr. Jones, said that experiments were not carried further than 25 foot-candles. It was assumed that, having reached daylight value, no practical advantage would be gained by exceeding it. It did not follow that a further increase in illumination would result in still greater visual acuity. In industry the maximum physiological visual acuity was seldom necessary, and in most processes the limiting factor was the degree of manual dexterity attained. The figures given for daylight output were included merely to show that the daylight conditions were normal. The day selected was not a dull one, and the output was therefore not unduly low.

The CHAIRMAN (Mr. D. R. Wilson), in proposing a vote of thanks to Mr. Weston, said he was sure that all present would agree that the paper was interesting and instructive. The paper had dealt with three main points: (1) the adequacy of lighting, (2) the actual system of lighting, and (3) the use of special spectacles, as illustrating the necessity for clear vision. The results in regard to adequacy were remarkably consistent; but he welcomed the suggestion that the conclusions should be tested on a large scale before final acceptance. There was little doubt that the illumination at present in use in most printing works was a great deal lower than it should be, and this very fact should facilitate tests in practice of the improved results following better lighting under practical conditions.

In moving this vote of thanks he also wished to refer to the great assistance derived from the printing industry. It had been an inestimable advantage to start *ab initio* with the co-operation of the industry.

The vote having been carried with acclamation, the CHAIRMAN also proposed a very cordial vote of thanks to the Stationers' Company for permitting the meeting to take place in the Court Room. Their historic building was an exceedingly appropriate place for the meeting.

The thanks of the Society were also expressed to the firms in whose premises the investigations were made, and to those who had worked under tests conditions.

Some Impressions of the Great Eclipse

By J. S. DOW

THE story of the total eclipse of the sun on June 29th has been told very fully in the general press. It is seldom that a great natural phenomenon attracts such widespread public interest, but the occasion was unique. It is over 200 years since a total eclipse was last visible in this country, and it will be 72 years before the opportunity recurs.

Moreover, in this country conditions are rarely really favourable to the observation of eclipses. On this occasion the sun was low on the horizon, and the initial illumination was consequently weak. Even in the most favoured areas, where the obscured disc of the sun was visible at totality (as at Giggleswick), it was only seen for a very short period through a hazy atmosphere and through a jagged gap in the clouds. The low altitude of the clouds rendered this visibility a matter of luck. Persons on the hills adjacent to the astronomers' camp had their view obscured at the critical moment. The writer's observations were made near Bentham (Yorks.), at a convenient station near the centre of the belt of totality, and about seven miles from Giggleswick. Of observers stationed within a few square miles in this vicinity, some had an uninterrupted view of the sun for ten minutes on either side of the moment of totality; others, like the writer, saw the sun shortly before the critical moment and a few minutes afterwards, but lost it completely during the 23 seconds of complete eclipse; others, again, apparently never saw the sun at all. On the whole, visitors to the west of Yorkshire seem to have been the most fortunate. They had at least a broken sky with considerable areas almost free from cloud; in many other regions within the belt of totality the sky was completely overcast. Hence the writer must consider himself lucky, notwithstanding the provoking passage of the sun behind a mass of thin cloud immediately before the period of totality.

When we took up our station the sky was heavily overcast and the illumination was low. Yet, from about 5-20 onwards, it was evidently partially clearing, and eventually portions of the sky in the south-east became almost free from cloud. For a time the diminishing thickness of cloud led to an actual increase in light, notwithstanding the fact that the eclipse had begun. It was at 6-10 that the sun first emerged as a watery crescent from the cloud, and hopes for a successful view of the corona rose high. But it was evidently a race between the eclipse and an approaching peak of cloud, and at 6-15 the sun disappeared again, only to reappear about 6-35, when totality was over. From this point onwards up to the end of the eclipse the sun was visible almost continuously, and during the later stages was even practically free from intervening haze.

It was at 6-15 a.m., with the disappearance of the sun, that the watchers first became conscious that the light was failing. There was a vague impression of gathering gloom. But the great change, when it came at the moment of total eclipse, was inconceivably sudden. Watchers became conscious of a dense gloom in the south-west, which advanced with great rapidity. Then there was an appalling downward swoop in the illumination. As one observer put it, "the whole sky seemed to be going out like a candle," and for a few seconds we were left in a species of twilight. It was just possible to read fairly bold type, but the faces of persons around were unrecognizable at a short distance. Most remarkable was the unearthly appearance of the sky, which assumed the colour of lead: the clouds were a livid grey, with at one spot just a tinge of pink from the invisible corona behind them. The darkness lifted even more suddenly than it fell; one was just conscious of the transference of the shadow to the hills in the north-east, which were blotted out in gloom. Ere long, the thin crescent of the sun emerged from the clouds, and the feeble sunlight was the more striking after the period of gloom.

The writer has witnessed several partial eclipses. In the case of the partial eclipse on April 17th, 1912 (when 92.7 per cent. of the sun's surface was obscured) the conditions were specially favourable. There was a clear sky, and the uncanny effect of the extinction of light, notwithstanding the continuation of the shadows and other conditions characteristic of sunshine, was sufficiently striking. In the total eclipse just witnessed these favourable conditions were missing. Nevertheless, in the writer's opinion, it was incomparably more impressive. Undoubtedly the appallingly sudden plunge towards darkness at the moment of totality was the main sensation. Quick diminution in light by thunderclouds is a familiar effect, but in the case of a total eclipse the change is far more rapid and intense than is ordinarily to be seen in nature, and—another significant point—the whole sky seems to darken simultaneously. One cannot escape the impression that the damage is irretrievable, that the sun will never return. Yet how much more impressive must be a total eclipse under ideal conditions—e.g., with a cloudless sky, in countries nearer the equator, and with a period of darkness lasting for six or seven minutes. The effect would then be accentuated by the passage from tropical sunlight to dense darkness. The clearer atmosphere would enhance the appearance of the corona and stars in the sky. In that case, too, one would see the sweep of the moon's shadow with a well-defined edge. Owing to the presence of clouds in front of the sun there was no clearly defined shadow from the author's viewpoint—merely a shapeless mass of gloom that bore down on us and then vanished.

One is led to regard the sudden extinction of light at the moment of totality as the most striking feature of the total eclipse (apart from the view of the corona) by comparing experiences with those of observers who were just outside the belt of totality. These agreed in reporting a diminution in light, but evidently the effect was insignificant in comparison with that witnessed near Giggleswick. The fact of even a minute portion of the sun's disc being continuously visible makes all the difference. Probably, too, observers situated just within the belt of totality would experience considerably less darkness than those at the centre, owing to stray light received from the adjacent only partially eclipsed regions of the sky. For the same reason it may be conjectured that the darkness at the centre of a belt of totality extending for 100 miles (as compared with about 30 miles in this case) would be much more intense; this factor would tend still further to increase the effect of a long-sustained eclipse in a country near the equator.

After this introductory description, let us now turn to the chief object of the author's visit—the record of measurements of illumination. It is understood that detailed observations of illumination have been conducted officially by members of the experimental parties, and the publication of these will be awaited with interest. The record here presented was a single-handed effort, so that very great accuracy could not be aimed at. During the actual period of totality—23 seconds—it was only possible to take and note down a few readings, especially as the illumination was constantly varying. Some part of this period was also naturally devoted to examination of the sky and the appearance of hills and surrounding objects. The value recorded (about 0.5 foot-candles should be regarded as an average. It is conceivable that at some instant during totality the illumination may have been considerably lower.

Owing to the variable cloud effects, the exact course of measurement of illumination would naturally vary enormously from point to point. Observation of the record presented in Fig. 1 at once reveals one curious point—the maintenance of an approximately even illumination during the first half of the eclipse, far lower than that recorded during the second portion. This is readily explained by the atmospheric conditions. As mentioned above, observations began with the sun at a low altitude and behind a dense bank of cloud. As the sun's altitude increased the illumination would normally increase also, but in this case there was another factor tending to increase of illumination—the gradual thinning of the

clouds. These two factors combined to neutralize almost entirely the continuous shadowing of the sun, so that it was only in the last quarter of an hour before totality that any marked diminution in illumination occurred.

This experience is sufficient to show how atmospheric conditions may almost entirely obliterate the effect of a partial eclipse when, say, 90 to 95 per cent. of the sun's disc is obscured. But it is otherwise with a total eclipse, and one would think that, even with a completely overclouded sky the sudden darkening at the moment of totality would always be striking.

The second half of the observations portrays much more nearly the normal change in illumination during an eclipse. During this period the sun was visible almost continuously, and in the final stages shone through an almost clear atmosphere. Hence a steep and steady increase in illumination up to 2,000 foot-candles is recorded—an increase due mainly to the passing of the eclipse, but also partly to the fact that the sun was still rising in the heavens.

This is possibly the first occasion on which photometric observations have been taken during a total eclipse. The writer and Mr. V. H. Mackinney, on the occasion of the partial eclipse of April 17th, 1912, took a series of observations which were presented at the Optical Convention in that year. The exceptionally clear sky and uninterrupted sunshine on that occasion resulted in records approximately much more closely to the normal effect of an eclipse. One striking fact was that the lowest illumination recorded (about 8 foot-candles) was just about 8 per cent. of the values recorded at the commencement and termination of the eclipse. As 92.7 per cent. of the sun's surface was obscured, the agreement with the calculated illumination was remarkable, and could not have been approached with a cloudy atmosphere.

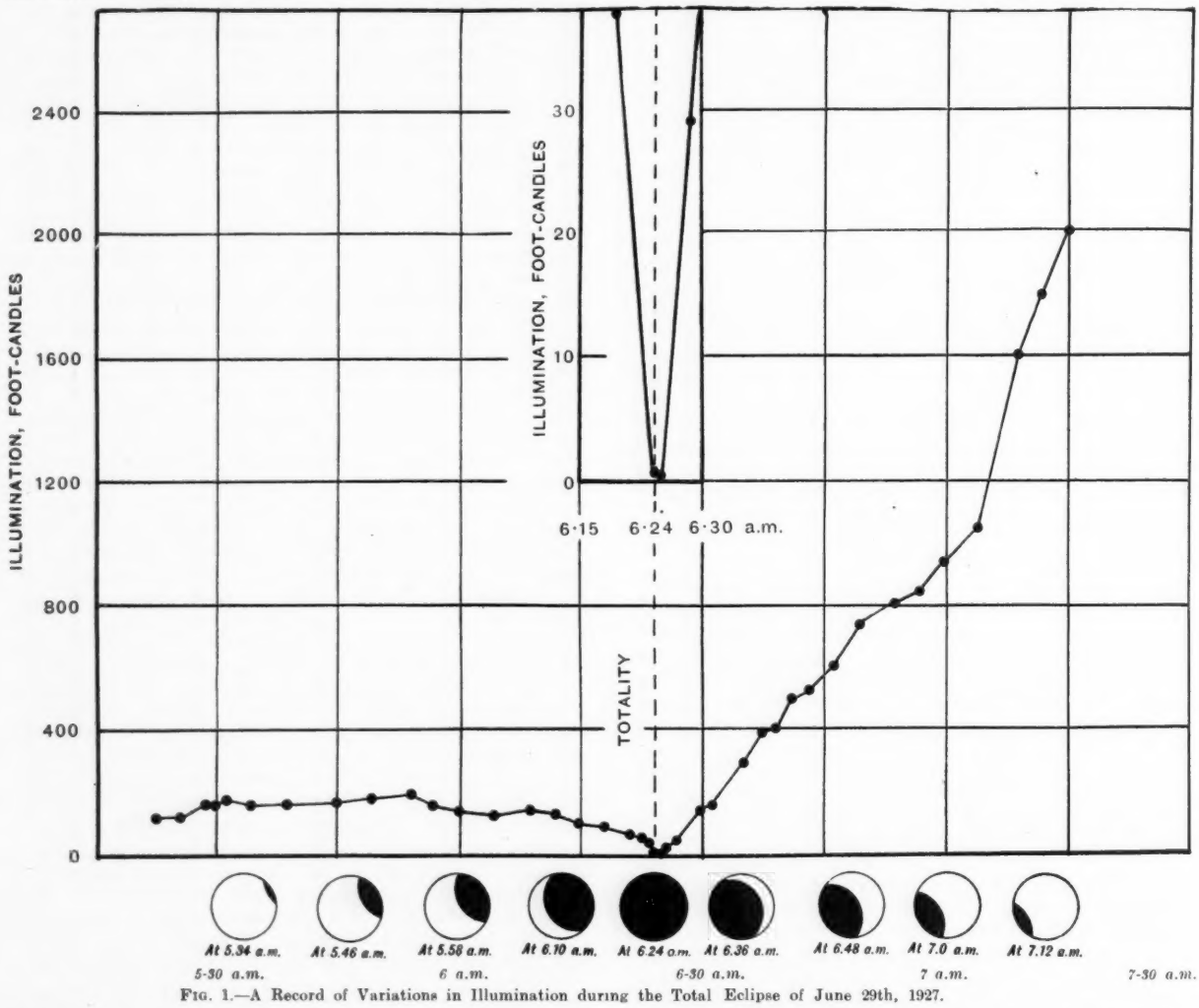


FIG. 1.—A Record of Variations in Illumination during the Total Eclipse of June 29th, 1927.

The most interesting measurement was naturally that taken during totality. Several observations, all in the neighbourhood of 0.5 to 0.6 foot-candles were taken. The immense drop to this value is naturally not clearly shown in the main diagram, owing to the scale necessarily adopted to enable the final high values to be recorded. But it is strikingly illustrated in the inset diagram, where observations taken during the total eclipse period and the few seconds on either side of it are recorded to a different scale. The extraordinary drop from 40 to about half a foot-candle in a few seconds illustrates the chief respect in which a total eclipse differs from a partial one. But possibly a chart of readings taken second by second during the period of totality would reveal another minimum, even lower than that shown in the inset diagram above.

It would doubtless be impracticable to predetermine the illumination resulting from a total eclipse. There do not seem to be sufficient data available to deduce the relative candle-power of sun and corona on which such a predetermination might be based, though if other photometric observers were fortunate in getting a clear view of the sun at the moment of totality their observations might furnish an indication. Quite apart from the interference of atmospheric conditions, the illumination might be expected to vary according to the width of the band of totality and the position of the observer within it.

In conclusion, the writer wishes to express his indebtedness to Holophane Ltd. for the loan of the latest model of a Holophane Lumeter, with which these observations were made. The yellow daylight screen was adopted throughout, and special neutral gelatine discs of known absorbing power were used, except during the period of totality. The measurements afforded an opportunity of judging the beneficial effect of the substantial improvements recently made in the design of this instrument.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

The Possibilities of Coloured Lighting

THAT colour has always possessed a universal appeal is evidenced by the discovery of beautiful coloured glasses and enamels among the remains of some of the earliest civilization, while the production of coloured fabrics and pictures provides employment at the present day for a large section of the community. The introduction of colour lighting, however, is of comparatively recent date. Indeed, it is only since the development of relatively powerful light sources such as the gasfilled lamp that coloured light of sufficient intensity and quantity for general application has been obtainable.

Coloured light can be produced in several ways:—

1. By splitting up white light into its component parts, as when a prism is placed in its path, e.g., rainbow or interference rings.
2. By filtering white light through a coloured screen which only transmits certain colours; e.g., gelatine screen, stained-glass windows, colour-sprayed lamps.
3. By reflection from a coloured object which absorbs all the rays falling on it except those of its particular colour, e.g., red handkerchief, coloured posters.
4. By employing certain light sources which give a preponderance of light of a definite colour, e.g., mercury-vapour arc, neon tubes, coloured lights.

Some of these methods depend upon the elimination of a considerable proportion of the original light, so that in order to obtain effective results the light source must be of a proportionately higher intensity. Some authorities consider that it should be doubled, but further data regarding this matter is given under "Solving Special Lighting Problems."

It should also be remembered that colours in the middle of the spectrum produce more visual effect than the reds or the blues, and that objects appear different in colour according to the nature of the impinging light.

The applications of colour lighting are almost legion, and in particular offer scope for artistic treatment in the modern shop window and also for domestic purposes.

In whatever sphere colour lighting is used it is important that the colours be chosen so that they do not clash with the environment, and this often involves a certain amount of experiment before satisfactory results are obtained.

In the lighting of interiors the colour of the lighting can be made to impart a psychological effect—orange or red, for instance, gives a sense of comfort and warmth, whereas blue and green give very different results.

Some charming effects can be obtained by using splashes of contrasting light—as, for example, a room generally lighted with golden light can be greatly improved by the introduction of one or two brackets with red shades, or table standards with red lamps.

Theatres.—Colour effects in theatres constitute a special subject. It may, however, be safely stated that the success of some present-day artistic productions depends in large measure upon the beautiful colour effects that are obtained electrically, while recent methods enable even the scenery itself to be projected in colour.

Coloured Floodlighting.—The possibilities of colour in this direction are quite fresh to this country, and great opportunity is presented for the use of contrasting colours.

Outlining for Exhibitions, Galas, etc.—For many years it has been common to outline the important buildings of exhibitions, bandstands, etc., at seaside resorts by means of electric lamps, but it is only since the introduction of sprayed lamps in recent years that coloured lighting has been extensively used.

The indiscriminate mixing of coloured lamps is to be discouraged. Far better results can be obtained by outlining sections in one colour, and picking out certain features only in a contrasting colour.

Signs.—It may be safely assumed that the coloured sign makes a stronger appeal to the senses than one consisting only of white lamps.

Methods in Use.—There are four commercial methods of producing coloured light from incandescent electric lamps:—

1. *Varnish.*—This has the advantage of being easily applied and obtainable in a large variety of colours, but this method is unsatisfactory, due to the fact that the colouring is far from permanent, especially when used on gasfilled lamps.

2. *Natural Glass Bulbs.*—There are good and sufficient commercial reasons for not producing a large range of tinted glass bulbs for lamps; chief among which is the practical difficulty of stocking.

3. *Sprayed Lamps.*—This process has the advantage of being cheap, while the diffusion of the light over the whole area of the bulb reduces the somewhat harsh effect obtained by other methods.

4. *Coloured Screens.*—This method employs the use of coloured screens of gelatine, glass, etc., which can be used in front of the fitting containing the lamp. This method lends itself admirably to obtaining effects in shop windows, on theatre stages, and other similar conditions where the results are being observed, as it were, from outside.

General.—The possibilities of coloured lighting are infinite, and it is impossible to prescribe rules for its use. Of all methods of lighting it requires the artistic taste for its exploitation, but anyone who is prepared to make a few experiments is sure to obtain a variety of pleasing effects. The appearance of objects under coloured lighting will differ greatly from that in daylight or white lighting. As a guide to the changes in the appearance,

reference should be made to the table given at the back of Handbook No. 4, which indicates the appearance of coloured objects when subjected to different coloured lights. In some instances effectiveness of coloured lighting can be still further enhanced by arranging for a full blending of different colours.

This gradual blending is tantamount to movement, and in exhibitions or shops is sure to prove attractive. A useful slogan is *Paint it with Light.*

Progress in Television

Successful television over 438 miles of telephone line between London and Glasgow is said to have been accomplished by Mr. John L. Baird. The experiments were made on May 26th, and are said to be preliminary to further experiments to be made shortly in attempts to bridge the Atlantic between London and New York. Mr. Baird's improved receiver is stated to embody many important technical advances, including a rapidly obtained synchronization between it and the transmitter. Subsequently this receiver will be installed in a building in New York, and immediate preparations made for an experimental transatlantic transmission by wireless. In the London-Glasgow transmission two telephone lines were used, one for conversation and the other for television, and it is reported that the received image, though small, was clear and distinct, revealing such movements as the turning of the head, opening and closing of the eyes, moving of the lips in speech, etc.—*The Engineer.*

Illuminating Engineering Society (U.S.A.)

The Twenty-first Annual Convention of the Illuminating Engineering Society (U.S.A.) is to be held in Chicago during October 11th to 14th. An interesting series of papers is being arranged, with an entire session set aside for central station men. Special attention will also be devoted to domestic lighting and aesthetic aspects of illumination.

The Sheffield Illumination Society

On Saturday, the 18th June, the Sheffield Illumination Society held their annual outing. This year a trip was made to Alton Towers, Staffordshire. A start was made from the offices of the Corporation Lighting Department at about 8-30 a.m. After passing through some delightful Derbyshire scenery, Alton Towers was reached at midday. After lunch the party explored the grounds and buildings of the Towers, the beauty of which is well known, until 3-30 p.m., at which time tea was served in the Alton Towers tea-rooms. After tea the party was allowed to see more of this interesting spot, and at 5 o'clock a start was made for Sheffield, which was reached at 8-15 p.m.

The outing, despite the heavy rain during the return journey, was successful and enjoyable, and reflects credit on the organizers.

Illuminated Hoardings and Electrical Advertising

By R. C. HAWKINS

(*District Engineer, Electric Lighting Service Demonstration Bureau, North-Western Province*).

(This contribution, kindly sent to us by Mr. R. C. Hawkins, was intended originally to form a paper to be read at the Advertising Convention at Blackpool last year. It will be recalled that, owing to the General Strike, this Convention had to be abandoned, and accordingly the paper, which contains a number of interesting suggestions for the use of light in advertising, was never delivered.—ED.)

IF a man were to open a number of shops in some of the best thoroughfares in the country, but did not provide any means of artificial illumination, he would undoubtedly miss a considerable number of possible purchasers. Numerous people would pass this shop after dusk, his wares would still be there, but the people would be unaware of them, and yet this is precisely the state of affairs existing to-day with respect to over 90 per cent. of poster hoardings in this country.

The posters are there, and in the great majority of cases a considerable amount of money has been spent in order to get them there. During the hours of daylight the posters are telling their story to passers-by, but after dusk they are almost inoperative. Just think for a moment exactly what this means. It means that practically the whole publicity value of the advertisement is lost during the evening hours. Now this is the time of the day during which the poster could make a great appeal, when the minds of the public are in a very receptive frame.

During the day only a limited number of people have sufficient leisure to study posters, but it is on the evening journey home, and after dinner when on the way to the cinema, or when taking the evening constitutional, that the mind is free. Business is over for the day, and it is then that the public are peculiarly receptive to anything which may present itself.

Surely, therefore, it would seem that something is wrong if over 90 per cent. of the posters in this country cannot be seen at this most important period of the day. In America advertising people have realized this, and the practice of electrically lighting hoardings is almost universal over there. They are going even one step further than that, for in many cases the artist selects his colours and designs his picture so that it will appear at its best when illuminated electrically. We in this country could well take a lesson from those who have proved beyond all doubt that the evening hours bring the greatest return on money invested in this form of publicity.

In order to obtain satisfactory results when lighting a hoarding, one or two important matters must be taken into consideration. Firstly, there must be enough light to make the poster stand out from its surroundings. The brightness required will depend, of course, entirely on the location. What would suffice for a suburban district would not be of the slightest use in Piccadilly Circus.

However, although definite rules cannot be laid down, there are certain standard recommendations to suit average conditions, and these may be stated briefly as follows:

If in a district of low circulation, that is to say, where the surroundings are moderately dark, one should employ one 100-watt lamp per 16-sheet poster. In brightly lighted districts one 200-watt lamp should be used for the same sized sheet. However, it must be borne in mind that under certain conditions it is economically desirable to increase these figures. A second requirement is that the poster should be illuminated evenly over its entire surface, for nothing looks more ugly than a series of dark patches between the lighting units. It is equally important that care be taken, to ensure that there is no reflected glare, that is to say, excessive light reflected from the poster into the eye of the observer.

The general practice in this country is to illuminate posters by means of lamps in specially designed reflectors placed at the top of the hoarding and projecting out from it. Unfortunately there are very rigid restrictions in many districts affecting the distance of overhang, but from a lighting point of view it is desirable to place the reflectors as far out as possible within limits. Five feet is a very convenient distance. The period during which posters are lighted is of the order of 1,500 hours per annum, and I propose to dwell for a moment on the cost of obtaining this great increase in the working life of the display. This may be classified under two headings:—

1. The initial outlay.
2. Running cost.

For this purpose I will take the case of a 48-sheet poster requiring three reflectors. The initial cost of the installation will, of course, depend entirely on the location of the hoarding, its distance from the electrical supply, etc., but I think a figure of £20, including lamps, reflectors, switches, cable, and all accessories, would be quite a reasonable average to assume. This would include also an allowance for interest and depreciation, assuming that the reflectors would require to be renewed after a period of about six hours. This period will vary very considerably, depending on the local atmospheric conditions and on the question of maintenance.

The running cost fortunately is very much more easy to determine. Let us assume that our poster is in a district of high circulation, and, therefore, we are going to employ two 200-watt lamps. The total energy consumption, allowing 1,500 hours' burning, will be 900 units per annum. The cost of current in this country varies very considerably, but for this class of work 3d. per unit is quite a reasonable amount. On this basis the total energy cost per annum is £11 5s., and the average cost per week will be 4s. 4d. This figure of 3d. per unit is a conservative one, and in many progressive districts to-day the charge would be nearer 1d. per unit. At this rate, the average energy cost per week would be approximately 1s. 5d. Now, if we have a 16-sheet poster instead of a 48-sheet, the average costs would be only one-third of these, that is, 1s. 5d. per week at 3d. per unit, and only 6d. per week at 1d. per unit.

At the Harrogate Convention last year Mr. Cyril Sheldon stated in his paper, "Posters and the Public," that the average cost of displaying a 16-sheet poster is about 1s. 8d. per week, this figure not including the initial outlay for the design, etc.; so it will be seen that with electricity at 1d. per unit the cost of lighting a 16-sheet poster in a district of high circulation, that is to say, the cost of extending its working life for 1,500 hours per year, is only 30 per cent. of the cost of displaying it. In a district of low circulation the cost would be only half this amount, that is to say, 15 per cent. of the cost of displaying. I do not think that this can be considered an exorbitant amount in view of the enormously increased publicity value.

So far we have discussed only the ordinary hoarding, but when we come to very large painted boards or even poster stations which are not readily accessible, this method of lighting from the top only is not sufficient. In some cases the addition of similar units at the bottom will make a satisfactory job, but, in general, other methods have to be looked for. The most common practice in such cases is to floodlight the display by means of projectors placed at some convenient spot. Here again it is not possible to lay down any definite laws, and each case must be taken entirely on its own merits.

In view of the greatly increased publicity value to be attained at such a very low cost, it is difficult to understand why every poster hoarding in the United Kingdom is not illuminated; and you may well ask why the electrical industry has not persuaded the billposters to do it. Well, we have tried to do it, and have obtained some

measure of success, there being a few outstanding examples in this country. However, the question does not appear to interest the average billposter, and there is a very strong conservative state of mind to overcome. I would venture to suggest that the national advertisers, who, after all, are the people who will benefit most, are the best equipped to do this, and that the pressure should come from them.

Up to the present we have been discussing only illumination of posters, but there are many other forms which electrical advertising can take which have certain definite characteristics possessed by no other advertising medium. The first of these is motion, and this never fails to attract attention. Another is brightness. The eye instinctively turns to the brightest object in view. Again, size is very important, and, with electrical methods of advertising, there is practically no limit to the possible methods of display. A still more unique feature of this form of publicity is the possibility of erecting two or more displays on one site, and, in view of the enormous sums of money expended on rent in some locations, this is worthy of consideration. The principal form of electrical advertising is the electric sign, and the word " sign " covers a multitude of things, from the massive erection filled with animated objects and flashing slogans down to the humble exit indicator in the cinema. But, whatever it may be, it tells a story. However, signs may be roughly classified under the following three headings:—

1. The exposed-lamp type.
2. The enclosed-lamp or box type.
3. The drifting-letter type.

(1) *The Exposed-Lamp Type.*—This has taken several forms in the past, but that most generally used to-day is one in which the lamps are carried in a metal trough. Time will not permit me to discuss fully the factors which influence legibility of this type, such as spacing and size of letters and lamps, but a great deal of experimental work has been carried out in order to obtain the best results. This is the type of sign usually employed when it is desirable to obtain motion, which may take three distinct forms:—

(*a*) Conventional movement such as a running border.

(*b*) Reproduction of real movement, i.e., a motor car, dancers, etc.

(*c*) Movement for movement's sake, such as a jazz design, which simply moves, and that is all.

In addition to the channel letter, there have recently been introduced several special letters which have for their object an improved daylight appearance.

(2) *The Enclosed-Lamp Type.*—This usually consists of a design painted on translucent glass or else stencilled letters forming the sides of a box, the lamps being placed inside. This type may be used for a variety of purposes far too numerous to mention here.

(3) *Drifting-Letter Type.*—This is rather a special type of sign, consisting of a bank of lamps across which a message is spelt out by means of a mechanical device. These signs are used for late news by a number of newspapers, and it is quite a usual practice to intersperse advertisement " copy."

Building Display.—The second chief class of electrical advertising is known as building display, and is used to focus attention to some particular structure. One way in which this can be accomplished is by outlining the main architectural features of the building with exposed lamps, and another is to incorporate an enclosed lamp sign in the facia. A still further method is to floodlight the building. In many cases one sees all of these methods combined in one display. Floodlighting, perhaps, is the method which appeals to most people, and remarkably beautiful effects can be obtained. A more recent development is to floodlight buildings in colour, but when this is done great care must be taken when selecting the colours, particularly if there is much white light in the vicinity.

The foregoing remarks indicate briefly some of the present-day possibilities of electrical advertising, but although it is being more extensively used in many directions there does not seem to be a general realization of the valuable publicity space available by the side of railway tracks.

In the very near future remarkable developments in the use of electricity will take place, and, in these, light will play a leading part. I would urge you, therefore, to think of electric light not as an intangible thing which produces a bill every quarter, but rather as a wonderful ally to your profession, and, above all, as a medium through which you may obtain even greater prosperity in the future.

Correspondence

THE LIGHTING OF PRINTING WORKS.

Sir,—I much regretted not being able to be present at the reading of Mr. H. C. Weston's paper at the meeting of the Illuminating Engineering Society on June 14th, owing to my absence from town.

I would, however, like to submit the following notes commenting upon Mr. Weston's paper, and trust that you will be able to include them in *The Illuminating Engineer*. These notes relate to an installation of " Restlight " illumination at the London School of Printing, and show that the conclusions stated in the paper in regard to " artificial daylight " do not in any sense apply to a " Restlight " installation.

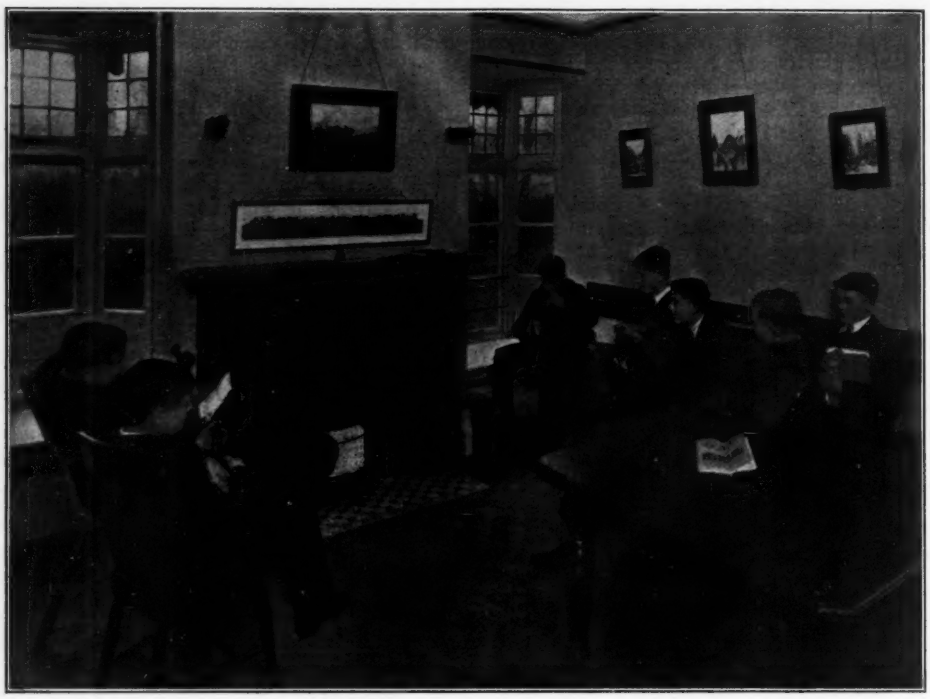
The original installation of uncorrected electric light in the foundry room at the School of Printing consisted of four 300-watt and two 500-watt lamps in opal glass bowls for general lighting, and twelve 40-watt bare lamps under opal shades on the working bench. The total consumption was, therefore, 2,680 watts. The general illumination was about 4 foot-candles on the working plane of the machines, and the illumination actually in use on the bench, under the local lamps, was 30 foot-candles.

This system was replaced by eight 14-in. " Restlight " bowl or semi-indirect units, each with one 150-watt lamp, and 14 small " Restlamp " pendants for local lighting on the bench, each using 60 watts. The total consumption was thus reduced to 2,040 watts—a diminution of 640 watts, or about 22½ per cent. The general illumination was increased to rather more than 6 foot-candles on the working plane of the machines. The light now required and in actual use on the working bench is on the average about 15 foot-candles, although, of course, this could be increased considerably (up to 60 foot-candles), if the local units are brought down to within a foot away from the work. I am unable to give actual figures for increased turnover and decrease in the number of errors, owing to L.C.C. regulations, but I am informed by the principal, Mr. Riddell, that the results in this respect are very satisfactory, and much better than any obtained with any other system of lighting tried.

These data suffice to show that the installation of " Restlight " does not involve an increase in consumption. The bowl units approximate to the type suggested by Mr. Weston as most effective, and the local units, while furnishing direct light, provide the shadows necessary for clear visualizing of type. Glare and eye-fatigue are eliminated, and the psychological objection of " coldness " does not arise owing to the resemblance between the spectrum of " Restlight " and that of natural sunlight. Other uncorrected light units were actually used for a time, but were removed at the request of the workers and heads of departments, who much preferred the soft white light given by the " Restlight " units.

This installation furnishes an indication of the expediency of bringing within the sphere of research all specialized lighting units which claim to achieve a solution of this difficult problem. I myself deprecate the use of very high standards of illumination. What is needed is light as nearly as possible resembling natural light, and of an intensity of the same order as that found in the average well-lighted room, i.e., about 10 foot-candles of daylight. It must be remembered that we are dealing with units at relatively close quarters which have not the diffusing powers of natural daylight. This is a point that is apt to be overlooked in comparisons between natural and artificial light. The ideal, in a room in which shadows are not required for purposes of definition, would be indirect lighting with artificial daylight; but considerations of expense of maintenance and the climatic conditions in our smoky cities preclude the adoption of this system at the present moment. The alternative is the adoption of some such system such as " Restlight," which fulfils practically all the essential requirements.—Yours faithfully,

E. J. HALSTED HANBY
(Joint Managing Director, Restlight Ltd.).



A college house-room which is always comfortably warm. No labour is involved in its heating; and no fuel is wasted when it is unoccupied, for the fire can be turned out when it is no longer required. The illustration shows one of a number of radiant gas fires in use in classrooms, sitting rooms, bedrooms, Masters' studies and other private rooms, in the Matron's bedroom, and in the Bursar's office of Weymouth College, Dorset. Gas is also used for cooking the meals of the boys and school staff.

Smoke Abatement in Schools

THE abatement of the smoke nuisance in our towns and cities is an end desired by all illuminating engineers. No apology, therefore, is made in publishing the following particulars showing the growing tendency of Education Authorities to substitute smokeless for smoke-creating fuels in their colleges and schools, thereby setting an example to be copied by the rising generation when later they plan out and equip their own homes, offices and factories.

One of the most important aspects of school welfare work is the provision of adequate warmth, coupled with efficient ventilation, in school classrooms.

There is a general movement in educational circles at the present time in favour of the reduction of the number of children in school classes to enable the pupils to receive more individual tuition from the teachers. The classrooms in ordinary use will therefore tend to become smaller rather than larger, and their efficient heating should present no insuperable difficulties.

Cold Classrooms.—At present, however, it is often the case that in the cold months (and also on cold days which frequently occur between spells of warm weather in the autumn and spring) classrooms are not sufficiently warm throughout the school day. Many teachers complain, too, that classrooms which become quite comfortably warm as the day advances frequently have too low a temperature during the first hour or two of the morning.

Cold Children.—Children cannot be expected to pay full attention to lessons and to do their best work if they are feeling cold. The fact that they are cold tends to develop in them a state of fidgetiness—a natural instinct to make movements of their bodies in order to generate warmth.

Antiquated and Defective Heating Systems.—This fairly common but unsatisfactory state of affairs is due mainly to the adoption of heating systems which are not sufficiently "elastic"; that is to say, systems which cannot easily be regulated from day to day and from hour to hour to provide the exact amount of artificial heat required.

Coal the Cause of the Trouble.—The trouble arises mainly from the use of crude coal. The early morning routine work connected with the heating of the classrooms in which open coal grates are installed consists of the caretaker putting a light to the fires some time before the school assembles, and "coaxing" those which do not draw up well. He is probably in the habit of getting every fire alight by, say, seven o'clock each morning during the winter months without regard to the temperature registered outside, which may be anything between 28° and 48° Fahr. The result is that on some days the classrooms at 9 a.m. are too hot, while on other days they are miserably cold when the children arrive. Colds are then caught. If the room is overheated some of the children—especially those who are poorly clad—catch chills, when, later, they go out into the cooler, damp air. If it is underheated they suffer as the result of sitting still in the cold atmosphere, and their suffering often results in the teacher wrongly closing windows instead of demanding more heat.

The Good Points of Coal Fires.—The open coal fire, despite its many drawbacks, was, from two points of view, a healthy system of heating. It gave out a large proportion of radiant heat—rays similar to those of the sun which pass through the air without heating, but impart their heat to the solid objects with which they come into contact.

Ventilation.—Further, it ventilated, as it warmed, by expelling the used-up air from the room through the chimney, and causing fresh air from outside to take its place.

In these respects the coal fire was to be recommended. But in almost every other respect it failed as an efficient and economical heating agent for school classrooms. Its use involved considerable labour. Large numbers of fires had to be raked out and then relaid, black-leading operations took up a considerable amount of time each week, and large quantities of coals and ashes had to be carted along corridors and up and down stairs. Teachers and pupils had their attention distracted from their lessons by the necessity of fairly frequent stoking opera-

One of several gas fires in the classrooms and bedrooms of St. Anne's School, Dorchester Road, Weymouth. The Principal states that she has found the stoves a great convenience and that, compared with coal fires, the "saving in expense is considerable."

tions. Smoke from the fires soiled the classroom walls and ceilings and contaminated the air; dust, too, settled on the desks, books, charts and other objects in the room.

The Coal Fire Must Go.—These disadvantages, coupled with its lack of adaptability to meet varying requirements caused by our changeable climate, rule out coal as an efficient agent for classroom heating.

The Solution to the Problem.—All of these difficulties can now be overcome by the adoption of more suitable methods.

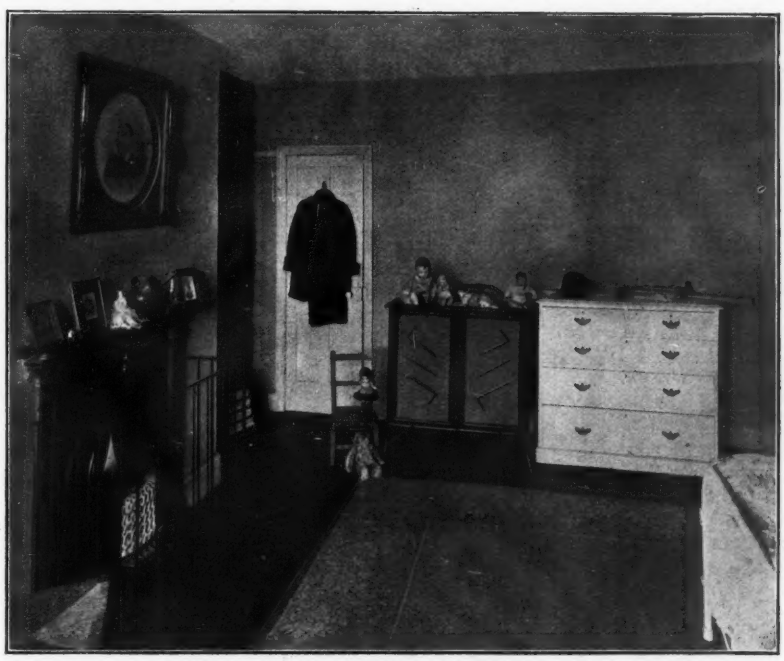
The most efficient substitute for the open coal fire is the radiant gas fire; and for heating large schoolrooms and school halls hot-water radiators and gas fires are the ideal combination.

Central Heating.—In large schools some form of central heating is necessary; and for this purpose it will often be found that the coke boiler is the most economical means for heating the water which circulates through the radiators. In some cases, however, a gas boiler will be more suitable, because its use may make it possible to dispense with the services of the man who has to be employed for stoking operations when a large coke boiler is installed. With the gas boiler, the only work involved in starting it up is the lighting of the burners. It then requires no further attention unless, on a fairly warm day, it is desired to turn it out because there is no need for artificial heat. In other cases the gas boiler may be preferable because of the lack of space for the coke boiler and for the stock of fuel. The cost for *fuel only* when the gas boiler is used will no doubt be higher than the cost of coke for similar work; but if the saving in labour and the value of the space left free by the gas boiler for more important purposes are taken into consideration, it will often be found that the total cost of central heating by gas is not more than the total cost of central heating by coke. It must be borne in mind, of course, that, owing to its ease of control, gas will be consumed only when heat is needed, and that the gas burners can frequently be turned out an hour or so before the school closes; whereas with a solid-fuel central heating system, to put the boiler out of operation at a moment's notice is impossible.

Advantages of Gas Fires.—Similar advantages are gained by the use of gas fires in classrooms. Here, again, the cost in *fuel only* for a period of *continuous* heating would be higher than that of coal fires. But, on the other hand, gas fires abolish all the drudgery involved in the use of coal fires. It must also be noted that the gas fires are lighted up only when heat is required, and that they can be turned out or down as soon as the temperature of the room tends to rise above, say, 60° Fahr.

The Dual System of Heating.—In a combined system of heating by hot-water radiators and gas fires it would be found that on many days the radiators were providing sufficient heat. On very cold days the gas fires would also be lighted up, and it would then often be the case that, after they have been alight for an hour or two, they could be turned either down or out. With this system the utmost possible economy is assured, and, what is equally important, the temperature of the classrooms can be regulated to a nicety with a minimum of effort. The gas fires would, of course be provided with flues, and these would carry out efficiently the valuable ventilating function which, as previously stated, was one of the outstanding advantages of the coal fire.

Heating by Gas Fires Only.—Many schoolrooms can be heated effectively by a gas fire only. In these cases it is well to provide a large fire with a duplex tap, so that when, in the early morning, the fire is turned full on it heats up the room quickly. When the desired temperature is attained, it will then generally be found that a portion only of the fire need be left alight. By turning the duplex tap to a certain position the supply of gas



A bedroom in St. Anne's School, Dorchester Road, Weymouth, showing a gas fire fitted in front of the original coal grate.

to some of the radiants at each side of the fire is completely cut off, and the centre burners only are left alight.

The fixing of gas fires in front of, or actually in, existing coal grates in school classrooms presents no difficulties, and the initial cost of the work is not heavy.

Several installations of gas fires in classrooms and other rooms in colleges and schools are shown in the accompanying illustrations.

An Early Experiment in Classroom Heating by Gas.—On the question of economy and other advantages of open gas fires for heating classrooms, the practical experience gained in one of the first public elementary schools to make the change-over from coal to this system of heating is of interest.

In October, 1924, eight gas fires were fixed in place of slow-combustion stoves and an open fire in St. Chrysostom's Church of England School, Everton. The head master, after the fires had been in operation for about three months, wrote a letter stating that:

> "They have proved thoroughly efficient and economical in use. The school atmosphere is cleaner; the rooms are easily kept at an even temperature; cleaning work and costs are lighter; there is no waste, the gas being immediately turned down by the duplex burner, or off when not required; and there is no worry with fires burning badly, going out, etc. . . . The schoolrooms are large classrooms accommodating 50 to 60 scholars; there is good cross-ventilation by windows in each room, and no deleterious effects on scholars' or teachers' throats have been found by the use of the gas fires. There are no fumes whatever, and the air in the rooms is changed as often as by an open fire."

Even Temperature Throughout the Room.—Soon after the fires were installed, the head master had tests made in the classrooms to ascertain whether an even temperature was obtained in all parts of the rooms. He suspended three thermometers in each room. The first he placed against the wall farthest from the fire; the second in the middle of the room; and the third near one or other of the corners of the room. He found as a result that the three temperature readings never varied by more than a degree or two.

Heating Costs Considerably Reduced.—The advantages enumerated above were obviously of great importance; but it must be remembered that the gas fires could not have been retained had the cost of heating proved to be greatly in excess of the cost of heating by solid fuel.

On this question, the head master, in the letter already referred to, stated that, during the winters of 1919 to 1923, *the average cost of coal, coke and firelighters* used for heating the rooms *was rather more than £2 10s. per week.*

Accurate records of the gas consumption were taken after the gas fires had taken the place of the solid fuel fires, and, with gas at the price charged locally, he found that *the average weekly cost for heating the classrooms by gas, and in addition lighting the school and heating water in a gas boiler for school-cleaning purposes, was just under £2 per winter week.*

These striking figures do not indicate, however, the total saving achieved by the adoption of gas in place of solid fuel.

Wages Bill Reduced.—When the solid fuel fires were in use, a caretaker and a "full-time" cleaner had to be employed. After the gas fires were installed it was found that the cleaner's services were required for only three-quarters of full time. This meant a further saving of from 6s. to 7s. a week in wages.

Space Saved.—Valuable space in the school premises was also released after the introduction of the gas fires. The cellar previously used as a store for solid fuel was turned into a caretaker's storeroom, and the shed previously used as the storeroom was dismantled. As a result of the removal of this shed, the area of the covered-in playground of the school was increased by 12 square yards.

It would be possible, if space permitted, to publish a number of letters from principals of schools expressing their satisfaction at the results obtained from gas fires, and mentioning in particular their economy; but the following extract from a letter from one of the principals of a school in Weymouth may be quoted as a typical example:—

> "We have found these stoves a great convenience, and the saving in expense is considerable. The labour and dirt occasioned by the old open coal fires has been done away with, and the temperature of the schoolrooms is more easily regulated."

Gas Fires for Oxford Colleges.—The tendency to adopt gas fires in college premises is growing steadily. In this connection it may be mentioned that nearly all the colleges in Oxford have some gas fires installed, and that in Magdalen, Exeter, Balliol, Worcester and New Colleges gas is used fairly extensively for heating. At New College in 1926 thirty of the undergraduates' rooms were fitted with gas fires. At Exeter College several "staircases" already have undergraduates' rooms provided with gas fires, each set of rooms being provided with a separate meter. At Balliol twelve additional gas fires were fixed in the winter of 1926, each fire having a separate meter; and at Worcester thirteen rooms were fitted with gas fires.

A classroom in St. Chrysostom's Church of England School, Everton, showing one of eight gas fires used for keeping the rooms warm during cold weather. No coal has been used in this school since the substitution of gaseous in place of solid fuel for heating nearly four years ago. As a direct result, *the school's fuel bill has been considerably reduced, and labour charges have dropped by over 6s. a week.* The average initial cost of substituting gas fires for coal fires was only £8 per fire.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

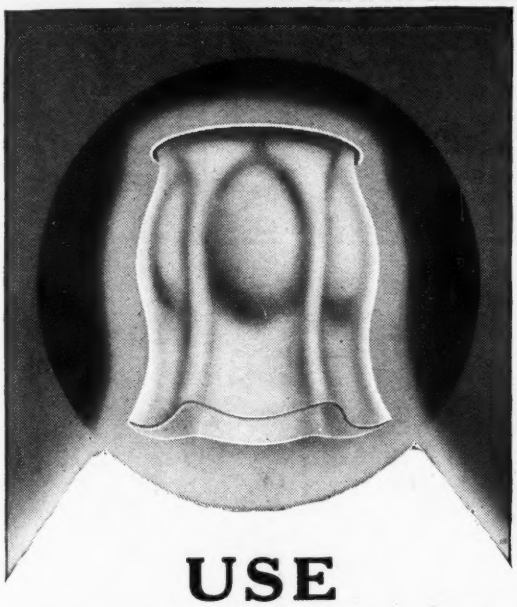
THE HISTORY OF THE INCANDESCENT LAMP, *by John W. Howell and Henry Schroeder. (Published by the Maqua Company, Schenectady, N.Y.*, 1927; *pp.* 208.)

This little book contains some curious and out-of-the-way information on early developments of electric lamps and lighting, and progress is traced up to the advent of the modern gasfilled lamp, the constructional details of which are dealt with in the later chapters. There are many illustrations, amongst which may be mentioned the reproduction of a page from the *New York Herald* of December 21st, 1879, announcing Edison's success in evolving a practical incandescent lamp. The book refers to many early researches on lamps which are not generally known. It is stated that T. D. Bottome applied for a patent based on the addition of tungsten to carbon as early as 1887; tungsten itself has been known since 1781. A photograph relating to Edison's visit to the Research Laboratory in 1922, with Dr. Coolidge demonstrating the swaging machine with which ductile tungsten could be commercially produced, shows Mr. Edison in a characteristic pose. Mr. Edison started to make a lamp factory at Menlo Park in 1880—47 years ago. The final chapter deals with the photometry of the incandescent lamp, and several pictures show integrating spheres in operation, in one case equipped with a photo-electric cell. Constructional details are treated in a similarly up-to-date manner, such processes as the now familiar inside frosting of bulbs being illustrated.

THE EMPIRE MUNICIPAL YEAR BOOK, 1927-28, *45th Annual Edition. (The Sanitary Publishing Co. Ltd., London; pp.* 318; *10s. 6d. net.*)

The forty-fifth edition of this well-known directory is welcome, and is as full of condensed information as its predecessors. This directory has a field of its own, in which the information presented is exceptionally complete. It furnishes officially corrected lists replete with all the Corporation, County, and Urban District Councils in Great Britain and Ireland, with the names of clerks, and municipal, highway, electrical and water engineers, medical and other officers of health, etc., as well as similar data for the most important foreign and colonial countries. This information is followed by sections containing condensed data on road construction and maintenance, plain and reinforced concrete, lighting, heating and ventilation, water supply, public health, town planning, etc., and a list of municipal engineering, public health and scientific societies is included. Lighting is very briefly dealt with, and one would like to see this section somewhat extended. In the next edition reference to the Standard Specification for Street Lighting will doubtless be made.

INDEX (August, 1927).



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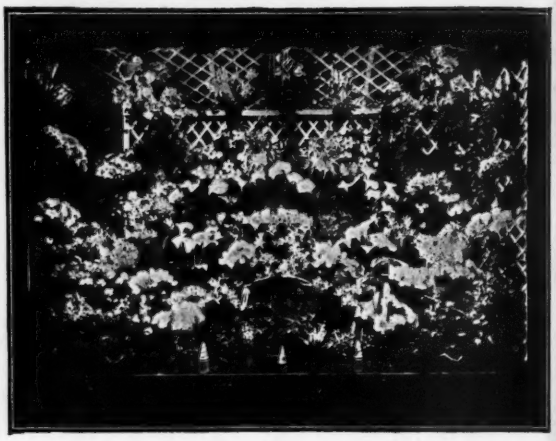
TRADE NOTES & ANNOUNCEMENTS

ARTIFICIAL DAYLIGHT FOR FLORISTS' SHOPS.

A good instance of opportunities for the use of artificial daylight is afforded by florists' shops, where the delicate colours of flowers suffer considerable distortion under uncorrected artificial light.

In the accompanying illustration we reproduce a view of an installation recently completed by Messrs. John E. Knight & Son at Wolverhampton. The lighting scheme for this window, which measures 12 ft. 6 in. in length, 10 ft. 6 in. in height, with a depth from back to front of 3 ft. 6 in., was planned by the British Thomson-Houston Co. Ltd. in collaboration with The Wolverhampton Corporation Electricity Department who carried out the installation work. Seven Mazda Daylight Lamps housed in B.T.H. X-Ray Reflectors are mounted above the window and spaced 1 ft. 6 in. apart.

The installation is considered a great success, the appearance of the flowers and foliage being most effective. There are, of course, many other applications for light approximating to daylight in quality, e.g., in artists' studios and in many industries where the appearance of colours is of importance.



Florist's Window illuminated by means of Mazda Daylight Lamps and X-Ray Reflectors.

FAREWELL DINNER TO MR. A. E. ILIFFE.

In connection with the Annual Sales Conference, Metro-Vick Supplies Ltd. gave a farewell dinner on July 1st, at the Engineers' Club, to Mr. A. E. Iliffe, who has resigned his appointment as sales manager to the company in order to take up the position as general sales manager to the Benjamin Electric Ltd.

Sir Herbert Morgan, Chairman of the Metro-Vick Supplies Ltd., presided; others present included Sir Philip Nash, K.C.M.G. (Chairman, Metropolitan-Vickers Electrical Co. Ltd.), Mr. A. McKinstry (Director of Sales, Metropolitan-Vickers Electrical Co. Ltd.), Mr. P. F. Crinks (Managing Director, Metro-Vick Supplies Ltd.), Mr. E. Cooke (Director, Metro-Vick Supplies Ltd.), together with all departmental managers, branch managers, and the general managers of allied factories.

In making the presentation to Mr. Iliffe of a gold cigarette case suitably inscribed, Mr. Crinks made special reference to the feeling of goodwill and friendship that had existed in the past, and assured Mr. Iliffe that the company wished to maintain that friendly spirit. Mr. A. E. du Pasquier, Mr. Cooke, and others, in their speeches wished Mr. Iliffe good luck and all success in his new appointment.

After the toast had been given with musical honours, Mr. Iliffe responded and said how he was touched by the many expressions of appreciation for what he had been able to accomplish with the company, and tendered his personal and sincerest thanks to all who had so loyally supported him and thus enabled success to be achieved. In thanking the company for its promise of continued friendship and help, he said that whilst he was changing his boat he still remained in the same sea, and that each might be able to shield the other from adverse currents, and thus help each other to reach prosperity with goodwill.

Mr. Iliffe will be commencing his new duties on the 4th August at the Benjamin Electric Ltd., Tottenham.

WARDLE LIGHTING EQUIPMENT.

The Wardle catalogue contains a very representative range of industrial lighting reflectors, distinguished according to type. The "Workslite" fittings are of the open-reflector type, in both dispersive and focussing patterns; one useful local-lighting device, the "girder" fittings, which are completely adjustable, deserves special mention. The "Inverlite" section covers a variety of units of the semi-indirect type, but intended for office and workshop use, whilst the "Wardelyte" fittings are of the totally enclosed diffusing form which is now so popular. In an introduction the chief photometric quantities are defined, and general hints on planning installations are given.

THE "THROLITE" SAFETY-FIRST LANTERN.

An interesting and ingenious device recently introduced by the Photector Co. Ltd. is the "Throlite" Safety-First lantern. This consists of the familiar "Throlite" concentrating reflector with a prismatic glass lining, upon which is mounted a separate fitting comprising several triangles of box section with glass fronts. The front of each triangle is illuminated by three tubular incandescent electric lamps, each consuming 30 watts. The fronts of the triangles are of ruby glass with a black centre, so that when illuminated the triangular sign in red stands out distinctly, furnishing the universally recognized danger signal.

The safety-first device is made throughout of copper sheet and fits snugly over the lantern. The glass fronts are hinged from the bottom so that they can be easily opened for the insertion or changing of lamps. Either one, two, three or four safety-first triangles may be fitted, the provision of this device being supplementary to the reflector, which fulfils its normal function of throwing a strong light downwards. The unit is thus admirably adapted for use at important junctions of streets, etc., where there is busy traffic and caution is necessary.

Luminous direction and danger signs are now playing an important part in the guidance of street traffic, and the device described above should be of considerable interest to authorities concerned with this subject.

STAGE LIGHTING AT THE CARLTON THEATRE.

With reference to the note which appeared in our last issue on the above subject, we are asked to make it clear that several firms participated in the equipment. We understand that the Strand Electric and Engineering Co. Ltd. supplied the main general stage-lighting apparatus, including five British-made four-colour "Sunray" battens and "Sunray" float, to the order of the electrical contractors, the Berkeley Electrical Engineering Co. Ltd. As already mentioned, the Schwabe-Haseit Cloud and Horizon Lighting and Dimming Apparatus was supplied by the General Electric Co. Ltd.

SIEMENS MONTHLY LIST.

We have to acknowledge the receipt of the Siemens Monthly General Price Sheet for July. As usual, this contains a great deal of useful condensed information, which should prove useful to purchasers of general electrical apparatus.